PB80-203151

Evaluation of Motor Vehicle Emissions Inspection and Maintenance Programs for Indiana

GCA Corp. Bedford, MA
GCA Technology Div.

Prepared for

Environmental Protection Agency, Chicago, IL
Region V

Oct 78

U.S. Department of Commerce
National Technical Information Service
NTIS

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-905/2-78-008	2.	3. RECIPIENT'S ACCESSION NO. PB80 203151
4. TITLE AND SUBTITLE Evaluation of Motor Vehicle Emissions Inspection and Maintenance Programs for Indiana		5. REPORT DATE Ocotber 1978 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Donna L. Vlasak et al		8. PERFORMING ORGANIZATION REPORT NO. GCA-TR-78-45-G(b)
9. PERFORMING ORGANIZATION NAME AND ADDRESS GCA Corporation, GCA/Technology Division, Bedford, Massachusetts 01730		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. Task B
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Region V, Air Programs Branch 230 S. Dearborn Street Chicago IL 60604		13. TYPE OF REPORT AND PERIOD COVERED Final 14. SPONSORING AGENCY CODE 5AHAP

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Data reported for the State of Indiana indicate that certain National Ambient Air Quality Standards will not be attained in all areas of the state by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the state will request from U.S. EPA an extension of the compliance data beyond 1982. In order for this request to be considered, the state must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. Currently, the State of Indiana is undertaking planning studies for the implementation of an I/M program. As part of this initial effort, several alternative programs have been analyzed from the standpoint of costs, benefits, and other requirements. These analyses, which are reported herein, will provide the basis for the state to select one specific alternative that will eventually be implemented.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Automobiles	Mobile source emissions Inspection/Maintenance Program Indiana	13B 13F
18. DISTRIBUTION STATEMENT Available only at NTIS	19. SECURITY CLASS *(This Report)* N/A	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* N/A	22. PRICE

EPA Form 2220-1 (9-73)

EPA-905/2-78-008

PB80-203151

GCA/TECHNOLOGY DIVISION

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

GCA-TR-78-45-G(b)

INDIANA STATE BOARD OF HEALTH
AIR POLLUTION CONTROL DIVISION
1330 West Michigan Street
Indianapolis, Indiana 46206

Indiana Project Officer

Christopher Bourke

EVALUATION OF MOTOR VEHICLE EMISSIONS INSPECTION AND MAINTENANCE PROGRAMS FOR INDIANA

TASK B

Final Report

October 1978

by

Donna L. Vlasak

Lee A. Coda

Theodore P. Midurski

Robert O. Phillips

Nancy K. Roy

Frederick M. Sellars

Thomas P. Snyder

GCA CORPORATION
GCA/TECHNOLOGY DIVISION
Bedford, Massachusetts

DISCLAIMER

This Final Report was furnished by the GCA Corporation, GCA/Technology Division, Bedford, Massachusetts 01730, in fulfillment of a contract to study inspection/maintenance (I/M) program alternatives for Indiana. The opinions, findings, and conclusions expressed are not necessarily those of the State of Indiana or of cooperating agencies. Mention of company or product names is not to be considered as an endorsement by the State of Indiana.

ABSTRACT

Data reported for the State of Indiana indicate that certain National Ambient Air Quality Standards will not be attained in all areas of the state by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the state will request from U.S. EPA an extension of the compliance data beyond 1982. In order for this request to be considered, the state must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. Currently, the State of Indiana is undertaking planning studies for the implementation of an I/M program. As part of this initial effort, several alternative programs have been analyzed from the standpoint of costs, benefits, and other requirements. These analyses, which are reported herein, will provide the basis for the state to select one specific alternative that will eventually be implemented.

Preceding page blank

CONTENTS

Abstract iii
Figures viii
Tables ix
Executive Summary. xvii

1. Introduction. 1
    Background 1
    Program Alternatives 9
    Basis and Organization of this Report. 11
    References 15
2. Methodologies 16
    Introduction 16
    Motor Vehicle Population Projections 16
    Determination of the Contractor Run Network. 17
    Contractor Network Cost Considerations 19
    Tocal Cost Methodology 31
    Personnel Requirements 33
    Emission Reduction Benefits. 37
    Determination of the Certified State Inspection Network. 37
3. Alternative 1 - Combined Emissions and Safety Inspections Performed Statewide by the Certified State Inspection Station Network. 44
    Alternative Definition 44
    Determination of the Certified State Inspection Station Network. 44
    Distribution of Certified State Inspection Station Network. 44
    Fee Calculations for the Certified State Inspection Network. 47
    Public Information Program Costs 49
    Possible Externalities and Legislative Considerations. . 53
    Emission Reduction Benefits. 53
4. Alternative 2 - Certified State Inspection Stations Performing Combined Idle-Mode Emission and Safety Inspections in Seven Nonattainment Counties - Certified State Inspection Stations Performing Only the Existing Safety Inspection in the Remainder of the State 55
    Alternative Definition 55
    Determination of Certified State Inspection Station Network. 55
    Distribution of Certified State Inspection Stations. . . 56

CONTENTS (continued)

Fee Calculations for the Certified State Inspection Station Network. 58
Public Information Program Costs 62
Possible Externalities and Legislative Considerations. . . 62
Emission Reduction Benefits. 63

5. Alternative 3 - Statewide Safety Inspection by Certified State Inspection Stations - Contractor Operated Idle-Mode Emissions Inspections in Seven Nonattainment Counties 65
Alternative Definition 65
Determination of the Contractor Run Network. 65
Contractor Network Cost Considerations 65
Total Alternative Costs. 78
Fee Computation 83
Possible Externalities and Legislative Considerations. . . 83
Emission Reduction Benefits. 85

6. Alternative 4 - Contractor Operated Combined Loaded-Mode Emissions Testing and Safety Inspection in Seven Nonattainment Counties - Certified State Inspection Station Conducted Safety Inspections in the Remainder of the State 88
Alternative Definition 88
Determination of the Contractor-Run Network. 88
Contractor Network Cost Considerations 91
Total Alternative Costs. 107
Fee Computation 109
Possible Externalities and Legislative Considerations. . . 111
Emission Reduction Benefits. 112

7. Alternative 5 - Contractor Operated Idle-Mode Emissions Inspection in Five Urbanized Areas - Certified State Inspection Station Operated Existing Safety Inspections in Five Urbanized Areas - Certified State Inspection Station Operated Combined Idle-Mode Emissions Testing and Safety Inspections in Rural Portions of Seven Nonattainment Counties - Certified State Inspection Station Operated Existing Safety Inspection Only in the Remainder of the State. 114
Alternative Definition 114
Determination of the Contractor Run Network 115
Contractor Network Cost Considerations. 116
Fee Computation 132
Determination of Certified State Inspection Station Network 132
Distribution of the Certified State Inspection Station Network 135
Fee Calculations for the Certified State Inspection Station Network 136
Possible Externalities and Legislative Considerations . . 140
Emission Reduction Benefits 146

CONTENTS (continued)

8. Alternative 6 - Contractor Operated Idle-Mode Emissions Inspection Only in Five Urbanized Areas - Certified State Inspection Station Operated Safety Inspection Only in Five Urbanized Areas - Certified State Inspection Station Operated Combined Idle-Mode Emission and Safety Inspection in the Remainder of the State. 148
  - Alternative Definition 148
  - Determination of the Contractor Run Network. 148
  - Contractor Network Cost Considerations 149
  - Total Alternative Costs. 165
  - Fee Computation 165
  - Determination of the Certified State Inspection Station Network. 165
  - Distribution of Certified State Inspection Stations. . . 165
  - Fee Calculations for the Certified State Inspection Station Network 170
  - Possible Externalities and Legislative Considerations. . 176
  - Emission Reduction Benefits. 177

9. Possible Externalities: Indirect Impacts 179
  - Introduction 179
  - General Program Impacts. 180
  - References 185

10. Legislative Considerations in Inspection and Maintenance Implementation 186
  - Introduction 186
  - Methodology 186
  - Possible Political Constraints 186
  - Potential Alternative-Specific Issues. 189
  - Concluding Remarks 192

11. Comparative Evaluation of Alternatives and Reference Matrix . 193
  - Comparison of Costs by Alternative 193
  - Comparison of Emission Reduction Benefits. 197
  - Comparison of Personnel Requirements 197
  - Possible Externalities and Legislative Considerations. . 197

Appendices

A. Detailed Description of Methodology for Calculating Emission Inventories. 205

B. Estimated Fuel Savings Resulting from I/M for 1987 224

C. Public Information Programs. 232

D. Sensitivity of Break-Even Fees 238

E. Detailed Description of Costs and Fee Calculations 240

F. Uniform Fee in Actual Dollars 244

G. Detailed Description of Methodology for Calculation of Motor Vehicle Inspections Required in 1982 and 1987. 246

Glossary 253

FIGURES

Number		Page
1	Schematic diagram of contractor-operated test lane combining emissions and safety inspections	8
2	The location of the seven nonattainment counties in Indiana	10
3	The location of nonurbanized portions of the seven nonattainment counties in Indiana	12
4	The location of the five urbanized areas considered for an I/M program in Indiana	13
5	Conceptual floor plan for a combined safety and loaded-mode emission inspection facility	24
6	Administrative network	34
7	Six Indiana I/M administrative regions	35
8	Market factors affecting private garage participation as Certified State Inspection Stations	40
9	Certified State Inspection Station Network for Indiana in 1987	45
10	Summary of fees with free reinspection and i = 0.03 (i = interest rate in absence of inflation)	198
11	Summary of fees with free reinspection and i = 0.06 (i = interest rate in absence of inflation)	199

TABLES

Number		Page
1	Motor Vehicle Inspections Required, 1982 and 1987	18
2	Outline of Program Cost Categories and Elements	20
3	Lane Area Requirements as a Function of Test Type	22
4	Estimated Instruction Cost for Instructor, Investigator, and Inspection/Mechanic Training	27
5	Certified State Inspection Station Network for 1987 Alternative 1	46
6	Inspection and Licensing Vans and Complaints Vehicles Needed to Assure Quality Control Over the CSIS Network for Alternative 1	47
7	CSIS Inspection Costs, Alternative 1, 1987 (Constant 1978 Dollars)	49
8	State Emissions Sticker Fee Calculations, Alternative 1, 1987 (Constant 1978 Dollars)	50
8(a)	State Emissions Sticker Fee Calculations, Alternative 1, 1987 (Constant 1978 Dollars)	51
9	Total Inspection Charge, (P) for Alternative 1, 1987 (Constant 1978 Dollars) i = 0.06	52
10	Daily Hydrocarbon Emissions for Alternative 1 (kg/day)	54
11	Daily Carbon Monoxide Emissions for Alternative 1 (kg/day)	54
12	Vehicle Registrations and Required Inspections for Nonattainment Counties in 1987	56
13	1987 CSIS Network in Seven Nonattainment Counties	56
14	Inspection and Licensing Vans and Complaints Vehicles Needed to Assure Quality Control Over the CSIS Network for Alternative 2	57

TABLES (continued)

Number		Page
15	CSIS Inspection Costs, Alternative 2, 1987 (Constant 1978 Dollars)	59
16	State Emissions Sticker Fee Calculations, Alternative 2, 1987 (Constant 1978 Dollars)	60
16(a)	State Emissions Sticker Fee Calculations, Alternative 2, 1987 (Constant 1978 Dollars)	61
17	Total Inspection Charge, (P) for Alternative 2, 1987 (Constant 1978 Dollars) i = 0.06	62
18	Daily Hydrocarbon Emissions for Alternative 2 (kg/day)	64
19	Daily Carbon Monoxide Emissions for Alternative 2 (kg/day)	64
20	Annual Number of Inspections Required by County for 1987, Alternative 3	66
21	Inspection Network Requirements for Alternative 3	66
22	Land Investment Costs for Each Facility in Alternative 3	68
23	Building Floor Area Requirements for Various Facility Configurations - Alternative 3	69
24	Building Cost Estimates for Alternative 3	70
25	Major Equipment Items Required and Unit Costs for Alternative 3	71
26	Equipment Costs as a Function of Facility Configuration for Alternative 3	72
27	Equipment Costs for Alternative 3	72
28	Administrative Personnel Costs Associated with Program Startup - Alternative 3	75
29	Annual Salary Expense for Facility Personnel	76
30	Annual Calibration Costs for Alternative 3	77
31	Taxes - Alternative 3	79
32	Annual Cost for Utilities/Supplies/Services	80

TABLES (continued)

Number Page

33 Annual Administrative Personnel Costs - Alternative 3 81

34 Cost Summary - Alternative 3 82

35 Contractor Fees, Alternative 3 (Constant Dollars). 83

36 Daily Hydrocarbon Emissions for Alternative 3 (kg/day) 86

37 Daily Carbon Monoxide Emissions for Alternative 3 (kg/day) . . . 86

38 Annual Number of Inspections Required by County for 1987 - Alternative 4 89

39 Inspection Network Requirements for Alternative 4 - Contractor Approach 90

40 Land Investments in Alternative 4 92

41 Building Floor Area for Various Facility Configurations - Alternative 4 93

42 Building Cost Estimates for Alternative 4 94

43 Major Equipment Items Required for Alternative 4 95

44 Equipment Costs as a Function of Facility Configuration for Alternative 4 96

45 Equipment Costs for Alternative 4 97

46 Administrative Personnel Costs Associated with Program Startup - Alternative 4 101

47 Annual Salary Expense for Facility Personnel. 102

48 Annual Calibration Costs for Alternative 4 103

49 Annual Taxes for Each Facility in Alternative 4 104

50 Annual Cost for Utilities/Services/Supplies 105

51 Annual Administrative Personnel Costs - Alternative 4 106

52 Cost Summary - Alternative 4 108

53 Contractor Inspection Fee Calculation, Alternative 4, 1987 (Constant 1978 Dollars) 110

TABLES (continued)

Number Page

54 Contractor Inspection Fees, Alternative 4, 1987 (Constant 1978 Dollars) 111

55 Daily Hydrocarbon Emissions for Alternative 4 (kg/day) 113

56 Daily Carbon Monoxide Emissions for Alternative 4 (kg/day) . . 113

57 Annual Number of Inspections Required by Urbanized Area for 1987, Alternative 5, Contractor Run Portion. 115

58 Requirements for Alternative 5 - Inspection Network. 116

59 Land Investments for Each Contractor Run Facility in Alternative 5 117

60 Building Floor Area for Various Facility Configurations - Alternative 5. 118

61 Building Costs for Alternative 5 119

62 Major Equipment Items Required for Alternative 5 120

63 Equipment Costs as a Function of Facility Configuration. . . . 120

64 Equipment Costs for Alternative 5. 121

65 Administrative Personnel Costs Associated with Program Startup - Alternative 5 124

66 Annual Salary Expense for Facility Personnel 125

67 Annual Calibration Costs for Alternative 6 126

68 Taxes for Alternative 5 128

69 Annual Cost for Utilities, Services, and Supplies. 129

70 Annual Administrative Personnel Costs - Alternative 5. 130

71 Contractor Network Cost Summary, Alternative 5 131

72 Contractor Fee Computation, Alternative 5, 1987. 133

73 Contractor Fees, Alternative 5 (Constant 1978 Dollars) 134

74 Relevant Vehicle Population and Number of Inspections Required, Certified State Inspection Station Network, Alternative 5, 1987 134

TABLES (continued)

Number		Page
75	CSIS Network for the Rural Portions of Seven Nonattainment Counties in 1987	135
76	Quality Control Vehicle Requirements, Alternative 5.	136
77	Average Annual Throughput, CSIS Emissions Inspection Network, Alternative 5	138
78	CSIS Inspection Fees, Alternative 5, 1987 (Constant 1978 Dollars)	139
79	State Sticker Fee Calculations, Alternative 5.	141
80	Total Inspection Charge (P), CSIS Network in Rural Portions of Urbanized Counties, Alternative 5, 1987 (Constant 1978 Dollars) (i = 0.06)	143
81	Average Hours Per Day Devoted to Inspection Activities, CSIS Emissions Inspection Network, Alternative 5	145
82	Daily Hydrocarbon Emissions for Alternative 5 (kg/day). . . .	147
83	Daily Carbon Monoxide Emissions for Alternative 5 (kg/day). .	147
84	Annual Number of Inspections Required by Urbanized Area for 1987, Alternative 6 - Contractor Coverage	149
85	Inspection Network Requirements for Alternatibe 6 - Contractor Approach in Urbanized Areas	150
86	Land Investments for Contractor-Run Facilities, Alternative 6	151
87	Building Floor Area for Various Facility Configurations - Alternative 6	153
88	Building Costs for Alternative 6.	154
89	Major Equipment Items Required for Alternative 6.	155
90	Equipment Costs as a Function of Facility Configuration for Alternative 6	156
91	Equipment Costs for Alternative 6	156
92	Administrative Personnel Costs Associated with Program Startup - Alternative 6	159

TABLES (continued)

Number		Page
93	Annual Salary Expense for Facility Personnel	160
94	Annual Calibration Costs for Alternative 6	160
95	Taxes for Alternative 6	162
96	Annual Cost for Utilities, Services, and Supplies.	163
97	Annual Administrative Personnel Costs - Alternative 6.	164
98	Contractor Network Cost Summary - Alternative 6	166
99	Contractor Fee Computation - Alternative 6, 1987	167
100	Contractor Fees - Alternative 6 (Constant 1978 Dollars). . . .	168
101	Annual Number of Inspections Required, 1987, CSIS Network for Alternative 6	168
102	Expected 1987 CSIS Network for Nonurbanized Portions of Indiana	169
103	Inspection and Licensing Vans and Complaints Vehicles Needed to Assure Quality Control Over the CSIS Network - Alternative 6	171
104	CSIS Inspection Fees, Alternative 6, 1987 (Constant 1978 Dollars)	173
105	State Sticker Fee Calculations - Alternative 6.	174
106	Total Inspection Charge (P), CSIS Network, Alternative 6, 1987 (Constant 1978 Dollars)	176
107	Daily Hydrocarbon Emissions for Alternative 1 (kg/day).	178
108	Daily Carbon Monoxide Emissions for Alternative 1 (kg/day). . .	178
109	Reference Matrix for Information on Each Indiana I/M Alternative by Page Number	194
110	Summary of Annual State and Contractor Costs and Fees (1978 Dollars)	195
111	Summary of CSIS Fees (1978 Dollars).	196
112	Summary of Hydrocarbon and Carbon Monoxide Emissions (kg/day).	200

TABLES (continued)

Number Page

113 Summary of Manpower Requirements (Annual Man-Years) 201

114 Data for Clark County 206

115 Data for Floyd County 207

116 Data for Marion County. 208

117 Data for Allen County 209

118 Data for Lake and Porter Counties 210

119 Data for St. Joseph County 211

120 Statewide Data 212

121 Travel Wighting Factor Calculation 214

122 Adjusted Data for Marion County 216

123 Adjusted Statewide Data 217

124 Hydrocarbon I/M Credits for LDV, LDT 1 and 2 218

125 Carbon Monoxide I/M Credits for LDV, LDT 1 and 2 219

126 Journey to Work by Auto 221

127 Proportion of VMT Subject to I/M Credits. 222

128 Potential Daily Fuel Savings From I/M for Selected Counties in 1987 (Gallons) 226

129 Travel Weighting Factor Calculation for Light-Duty Vehicles. . . 227

130 EPA MPG Specifications and Average Fleet Mileage for LDVs Covered by I/M in 1987 229

131 Estimated Daily Light-Duty Vehicle VMT Figures for Selected Counties and Areas for 1987 230

132 Estimated 1987 Vehicle Registrations for Indiana Areas Potentially Affected by I/M 236

133 Increase in Break-Even Fees (f_c) With a 25 Percent Increase in Test Personnel Wages (i = 0.03) (Constant 1978 Dollars). . . . 238

TABLES (continued)

Number Page

134 Increase in Break-Even Fees (f_c) with a 25 Percent Increase in Test Personnel Wages (i = 0.06) (Constant 1978 Dollars). . 239

135 Fee, f_a, Amortization Factors 242

136 Fee f_a and Cost Components (1978 Dollars) 245

137 1975 (Base Year) Populations, Urban and Rural Portions of Non-attainment Counties 247

138 Annual Rates of Population Growth, 1960-1975. 248

139 Population Projections, 1982 and 1987 249

140 Calculation of Motor Vehicles/Capita Ratio for 1982 and 1987. . 250

141 Motor Vehicle Populations, 1982 and 1987. 251

142 Motor Vehicle Inspections Required, 1982 and 1987 252

EXECUTIVE SUMMARY

INTRODUCTION

Need for Inspection and Maintenance Programs

Amendments to the Clean Air Act enacted in 1970 established National Ambient Air Quality Standards (NAAQS) for a number of pollutants including carbon monoxide (CO) and photochemical oxidants (O_x). Further, amendments enacted in 1977 require that the NAAQS for both CO and O_x be attained in all areas no later than 31 December 1982. The U.S. Environmental Protection Agency requires that all states submit revisions to their existing State Implementation Plans (SIP) early in 1979 demonstrating that areas currently violating the NAAQS will be in compliance by 31 December 1982. If it cannot be demonstrated that, even with the application of all reasonably available control technologies, the standards will be obtained, EPA may grant an extension to 31 December 1987 providing that the state meets certain requirements; one such requirement is the establishment of a specific schedule for implementing a motor vehicle inspection and maintenance (I/M) program in urban nonattainment areas with populations greater than 200,000.

Recent ambient air quality data for the State of Indiana indicate widespread and frequent violations of the pollutant standards. Further, it is doubtful that all areas in the state can be brought into compliance by 11 December 1982. As a result, it is quite likely that an I/M program will be required in several areas of the state.

What Are Inspection and Maintenance Programs?

Beginning with 1968 model-year vehicles, automobiles manufactured in or imported into the U.S. have had to comply with emission standards specified in the Federal Motor Vehicle (emission) Control Program (FMVCP). Under this program, maximum emission rates are established for new vehicles, and manufacturers must demonstrate through an auditing program that their vehicles are in compliance with these emission limits. The emission standards specified by the FMVCP require progressively more stringent control of emissions with each subsequent model year.

To comply with the emission standards, manufacturers have retained their existing engine design concepts, but developed emission control devices (crankcase ventilation control, catalytic converters, etc.) and revised certain system parameter specifications (air-to-fuel ratio, ignition timing, etc.). This approach to emission control ostensibly satisfied the requirements of the FMVCP for new vehicles. However, surveillance studies conducted by EPA disclosed that the emission rate for these "controlled" vehicles generally increased with time at a much greater rate than was expected, therefore reducing greatly the overall effectiveness of the FMVCP. Further analyses determined that the root causes of the rapid deterioration of these emission control systems could be traced to either improper or inadequate maintenance, or tampering with the devices or system settings.

In light of these findings, effort has been expended on developing techniques for reducing the air quality impact of poor maintenance practices and tampering. One result of this effort is the evolution of the inspection and maintenance concept.

In its most basic sense, inspection and maintenance refers to a program where vehicle exhaust emission levels are measured during specified operating conditions and compared with a specified standard for that particular vehicle configuration. If the measured rate exceeds the standard, the need for some form of maintenance, adjustment or repair is indicated. This is a very simplistic explanation of I/M, but it does serve to define the basic concept involved. A more precise discussion of various technical aspects of I/M may be found in the background report preceeding this document, entitled "Summary Report on Vehicle Emissions Inspection and Maintenance Programs."[1]

I/M Program Decision Variables

The establishment of an I/M program requires decisions to be made concerning a variety of program characteristics. Depending on certain policy decisions regarding alternatives and characteristics, an I/M program can take a variety of different forms. Program alternatives selected for evaluation differ from one another primarily in terms of such decision variables as: ownership and operation of test facilities, type of emissions test performed, and geographic coverage. Each of these decision variables is discussed below.

Ownership and Operation of Test Lanes—

An important decision which the state must make in selecting an I/M program concerns the ownership and operation of test lanes and equipment. (This issue has been discussed in detail in the Technical Memorandum No. 2.)[2] The reader is also referred to the material in Sections 3 through 8 of this document in which the six alternatives are described and evaluated. The two main types of organizational structures which Indiana has chosen for conducting I/M programs are:

1. Contractor: Centralized facilities operated by a private corporation under contract to the state (as in Arizona and California); and

2. Certified State Inspection Stations (CSIS): Decentralized facilities (garages, service stations, or new car dealers) certified or licensed by the state (as in Rhode Island and Nevada).

Different types of facilities can be used in different geographic regions of the state as seen in many of the alternatives chosen by Indiana. For example, alternative 6 combines a contractor approach for five urbanized areas with the certified state inspection stations in the remainder of the state.

Each of the two organizational approaches has various advantages and disadvantages. The contractor approach allows for greater accuracy in testing, better quality assurance, and better consumer protection, but incurs higher capital costs. The properly planned certified state inspection station offers greater consumer convenience but due to the lack of separation between the inspection and maintenance function may offer less consumer protection. Also, there may be problems in quality assurance due to variability in testing equipment and calibration practices. The costs and benefits of the two approaches are discussed in detail in Sections 3 through 8.

Type of Emissions Test--

Another important issue in inspection/maintenance programs concerns the type of emissions testing (idle or loaded mode) performed. A detailed discussion of testing procedures may be found in a document entitled "Technical Memorandum No. 3, Test Mode (Idle, Loaded)."[3] Basically, the idle mode test consists of measuring exhaust gases from the vehicle in neutral gear at idle speed and/or at high idle (usually 2500 rpm). The loaded mode makes use of a chassis dynamometer so that emissions can be measured during simulated driving conditions. The accuracy of the idle test is approximately equal to that of the loaded test in identifying gross emitters, however, the loaded test provides better diagnostic information as well as measuring nitrogen oxide (NO_x) emissions, which the idle test cannot. Indiana has chosen to investigate both test types in the six alternatives.

Geographical Coverage--

Geographic coverage refers to the areas in which registered vehicles are subject to I/M. The primary reason for inclusion or exclusion of an area in I/M program coverage has to do with the local motor vehicle population density as well as the severity of the air pollution problem.

The U.S. EPA has issued guidance to the states concerning minimum standards for geographic coverage. In an EPA memorandum entitled "Inspection/Maintenance Policy" dated 17 July 1978, David A. Hawkins, Assistant Administrator to Air and Waste Management, issued the following statement concerning geographic coverage:

> "I/M should focus on metropolitan areas and should include the entire urbanized area and adjacent fringe areas of development. Boundaries of the area affected may be adjusted if an equivalent emission reduction is achieved. For urbanized areas of 200,000 population or greater which need I/M to obtain an extension of the 1982 attainment date, full mandatory I/M must be implemented by December 31, 1982 for new centralized programs, and December 31, 1981 for all other programs. Statewide programs are encouraged, especially for those states which are small and highly urbanized.

> It should be emphasized that all nonattainment areas must have SIP's which are adequate to attain and maintain the National Ambient Air Quality Standards (NAAQS) by 1982 or by no later than 1987 should an acceptable nonattainment demonstration be made. For areas under 200,000, EPA will not at this time automatically require I/M schedules in 1979 as a condition for SIP approval or an extension. However, areas under 200,000 still have to attain and maintain NAAQS as expeditiously as practicable, and I/M is encouraged as a means of helping to provide for an adequate SIP. EPA will review the need for I/M in areas under 200,000 after the 1979 SIP revisions are submitted, and will consider additional requirements at that time."[4]

Background of Efforts to Develop an Indiana Inspection/Maintenance Program

Given the requirements of the Clean Air Act Amendments of 1977 under which Indiana must establish an I/M implementation schedule, a decision was made to initiate efforts to identify general requirements for I/M in the state. In this effort, the Air Pollution Control Board (APCB) has been designated the overall policymaking body. The Air Pollution Control Division of the Indiana State Board of Health (APCD-ISBH) has been designated to provide technical assistance to the APCB in matters relating to policy decisions. Professional services have been obtained to assist the APCB in connection with the evaluation of the HC and CO reduction potential of a motor vehicle emissions inspection and maintenance program.

Initially, the APCB with the assistance of the APCD-ISBH requested a summary of available program designs. Background data regarding technical and administrative aspects of I/M programs as well as a summary of the experiences of various states with existing I/M programs, were developed and provided through a series of technical memoranda and a summary report. These reports provided state officials who are responsible for development of the SIP revisions and the I/M program with general technical and nontechnical information. These documents served as a basis for making preliminary choices of specific I/M program alternatives for further investigation.

Summary Report and Checklist of Issues--

A review of the current literature in the area of motor vehicle inspection and maintenance (I/M) programs was undertaken with the intent of producing an overview of the concepts involved in I/M and indicating what the experience in the field has been regarding implementation and operation. The overview considered, among other things, the rationale for I/M and basic program configurations, as well as delving into a number of issues related to program administration and organization. Specific cross-references to the EPA compendium, "Information Document on Automobile Emissions Inspection and Maintenance Programs," were included to lend clarity by providing examples of state programs that have already been implemented and are currently operating.

Finally, to assist the decisionmakers in identifying several possible program configurations for more detailed study, a "Checklist of Issues" was developed. This checklist is a simple restatement of key elements to be considered at the first level of program development.

Technical Memoranda--

A series of detailed discussions concerning testing programs, ownership of test lanes and equipment, and test modes were prepared for the state. These went beyond the very general summary document in describing specific technical issues basic to I/M.

Based in part on the data provided, the APCB in its meeting of 24 May 1978, selected six specific Indiana I/M program alternatives for further study. Each is described here. The six alternatives were to be evaluated with the intent of providing the technical staff of APCD-ISBH with a comparative analysis. This comparative analysis would evaluate costs, benefits, and personnel requirements as well as other considerations regarding I/M implementation in Indiana. The details and conclusions of this analysis are presented in this report.

PROGRAM ALTERNATIVES

The Indiana Air Pollution Control Board's selected alternatives vary according to ownership of test facilities, test type, and geographic coverage; they have in common other program factors. A short description of each alternative follows:

- Alternative 1
    - Certified state inspection stations (private facilities) performing idle mode emissions inspection as well as the existing safety inspection statewide.
- Alternative 2
    - Certified state inspection stations (private facilities) performing idle mode emissions inspection as well as the existing safety inspection in seven nonattainment counties.
    - Existing safety inspection (no emissions inspection) in remainder of state (see Figure 1).
- Alternative 3
    - Contractor operated emissions inspection independent of existing safety inspection in seven nonattainment counties. Idle mode emissions inspection with capacity to expand to include safety inspection.
    - Existing safety inspection (no emissions inspection) in remainder of state (see Figure 1).

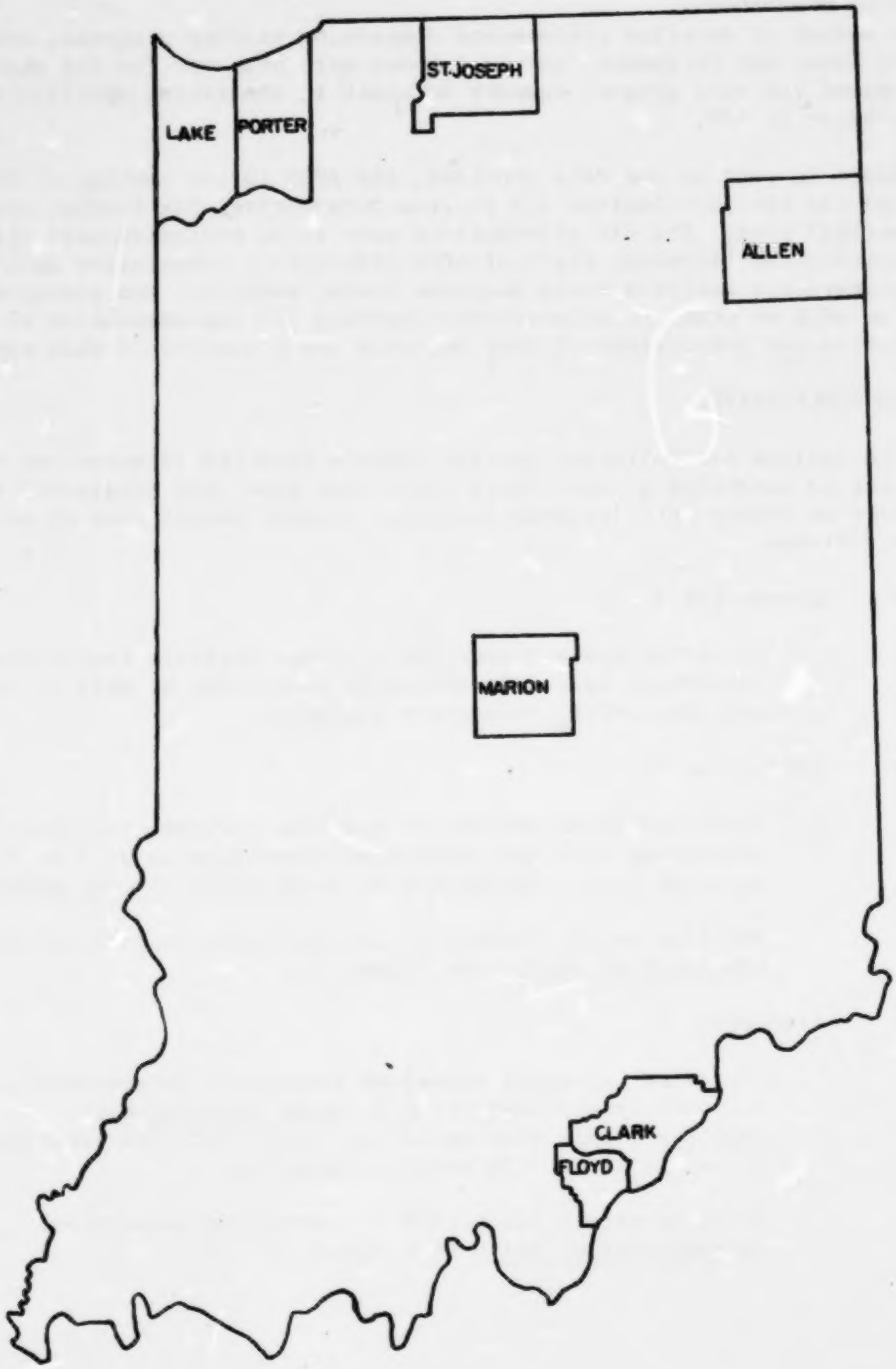

LAKE
PORTER
ST.JOSEPH
ALLEN
MARION
CLARK
FLOYD

Figure 1. Seven Nonattainment Counties.

- Alternative 4
  - Contractor operated loaded mode emissions and safety inspection in seven nonattainment counties.
  - Existing safety inspection (no emissions inspection) in remainder of state (see Figure 1).
- Alternative 5
  - Contractor operated emissions inspection independent of existing safety inspection in five urbanized areas. Idle mode emissions inspection with capacity to expand to include safety inspection.
  - Certified state inspection stations (private facilities) performing idle mode emissions inspections as well as existing safety inspection in nonurbanized portions of the seven nonattainment counties.
  - Existing safety inspection (no emissions inspection) in remainder of state (see Figure 2).
- Alternative 6
  - Contractor operated emissions inspection independent of existing safety inspection in five urbanized areas. Idle mode emissions inspection with capacity to expand to include safety inspection.
  - Certified state inspection stations (private facilities) performing idle mode emissions inspection as well as safety inspection in remainder of state (see Figure 3).

In the six program alternatives chosen for evaluation, the APCB has stipulated three different forms of geographic coverage, which are defined as follows:

- Five Urbanized Areas: In Indiana, there are four urbanized areas having populations equal to or greater than 200,000; these are Gary-Hammond, South Bend-Elkhart, Fort Wayne, and Indianapolis. For completeness, the Indiana portion of the Louisville urbanized area has also been included in this designation. The boundaries of these five urbanized areas as drawn by their respective metropolitan planning organizations (MPO's) are I/M program limits in alternatives 5 and 6. The five MPO's and their cities are:

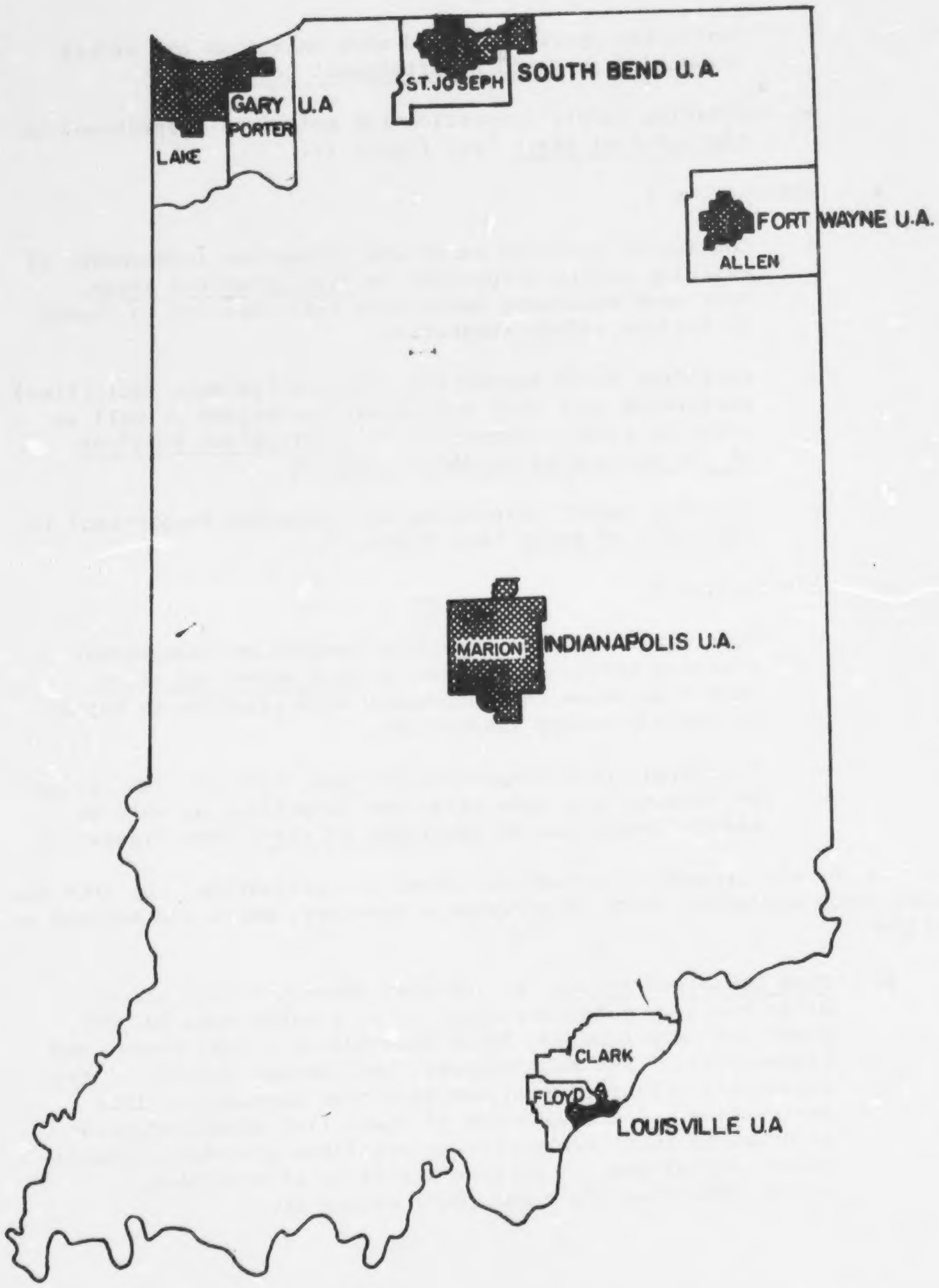

GARY U.A
LAKE
PORTER
ST.JOSEPH
SOUTH BEND U.A.
FORT WAYNE U.A.
ALLEN
MARION
INDIANAPOLIS U.A.
CLARK
FLOYD
LOUISVILLE U.A

Figure 2. Nonurbanized Portions of the Seven Nonattainment Counties.

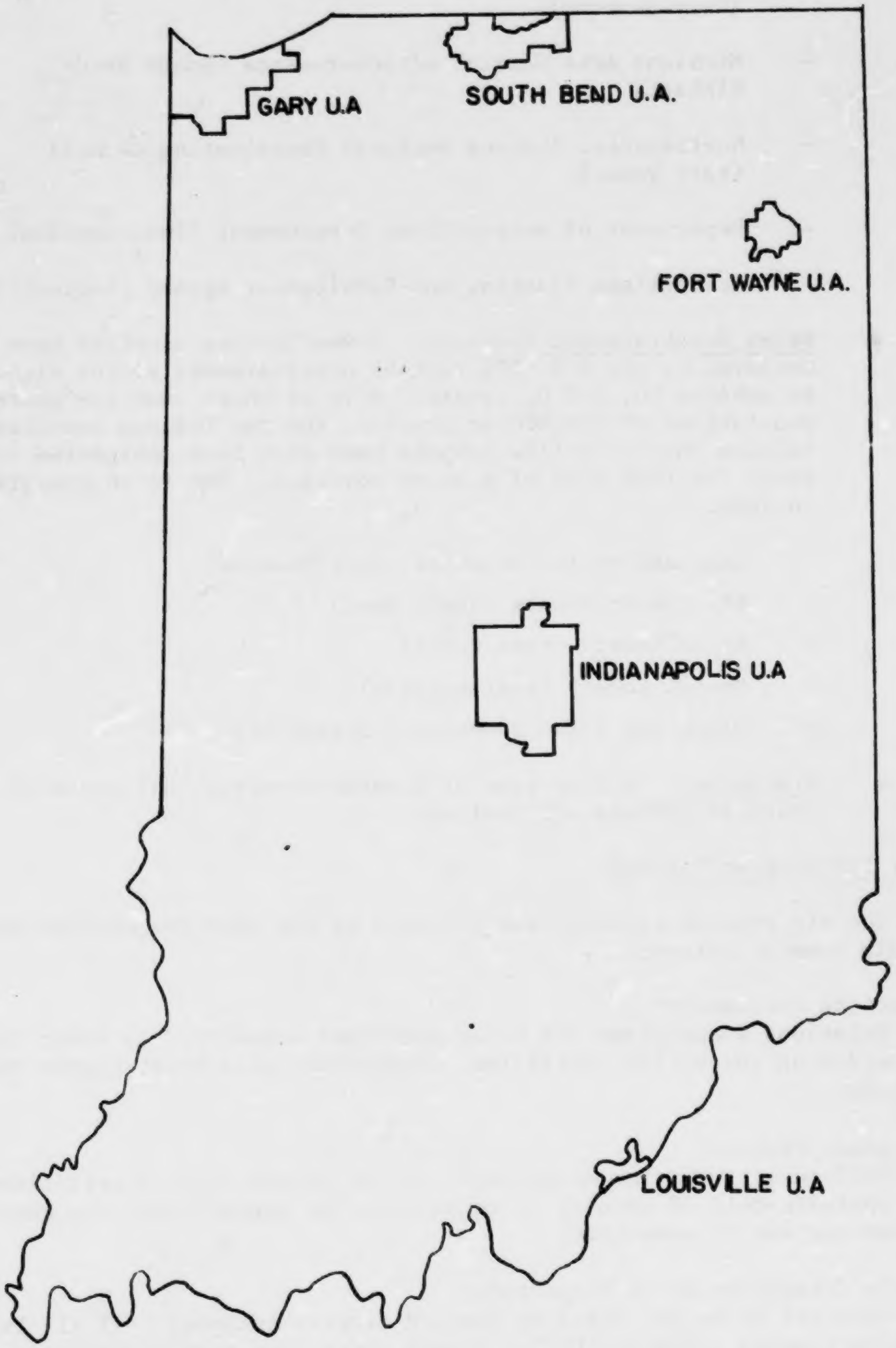

GARY U.A
SOUTH BEND U.A.
FORT WAYNE U.A.
INDIANAPOLIS U.A
LOUISVILLE U.A

Figure 3. Five Urbanized Areas.

- Northwestern Indiana Regional Planning Commission (Gary-Hammond)
- Michiana Area Council of Governments (South Bend-Elkhart)
- Northeastern Indiana Regional Coordinating Council (Fort Wayne)
- Department of Metropolitan Development (Indianapolis)
- Kentuckiana Planning and Development Agency (Louisville)

- Seven Nonattainment Counties: Seven Indiana counties have been declared by the U.S. EPA to have nonattainment status with regard to ambient CO, and O_x levels. Five of these counties contain urban populations of 200,000 or greater; the two Indiana counties containing the Louisville suburbs have also been designated as I/M areas for this type of program coverage. The seven counties include:
  - Lake and Porter Counties (Gary-Hammond)
  - St. Joseph County (South Bend)
  - Allen County (Fort Wayne)
  - Marion County (Indianapolis)
  - Clark and Floyd Counties (Louisville)
- Statewide: In this type of program coverage, all areas of the state of Indiana are included.

Other I/M Program Factors

The six program alternatives selected by the APCB for evaluation have certain common factors:

Inspection Frequency--

Emissions inspections are to be performed annually. In order to avoid overburdening inspection facilities, inspections will be staggered throughout the year.

Stringency Factor--

Failure criteria for measured HC and CO levels will be established such that approximately 30 percent of those vehicles tested fail, and hence, undergo maintenance and reinspection.

Vehicle Categories to be Inspected--

Vehicles to be inspected in the I/M program include: (a) all light-duty gasoline-powered vehicles (LDV's) except those less than 1 year old or greater than 13 years old (based on model year); and (b) all light-duty gasoline-powered trucks (LDT) with a gross vehicle weight (GVW) of 8,500 pounds or less.

Inspector and Mechanic Training--

Individuals performing either inspection or maintenance functions under the I/M program will be required to participate in a state-sponsored training course in which the objectives of the program, as well as inspection/maintenance and repair techniques are examined.

Lead Agency--

The Air Pollution Control Division of the Indiana State Board of Health (APCD-ISBH) is to exercise overall administrative control of the I/M program. The APCD-ISBH may be assisted in its administrative duties by other state departments working under cooperative agreements. For alternatives 1, 2, 5 and 6, emissions inspections will be carried out in conjunction with the existing safety program presently administered by the Department of Traffic Safety. For this reason, at this level the organizational network is conservatively defined.

Enforcement--

Enforcement for each of the six I/M program alternatives will be through the motor vehicle registration process. It is assumed that the registration process is flexible enough to accommodate any change required for enforcement of I/M in the future.

Safety Inspection--

The existing motor vehicle safety inspection program will continue either in conjunction with or in addition to the I/M program, depending on the program alternative selected. In general, certified state safety inspection stations are privately-owned establishments licensed by the Vehicle Inspection Department of the State of Indiana to inspect vehicles. They will be referred to as "Certified State Inspection Stations" (CSIS).

Funding--

The I/M program will be entirely self-supporting. Motorists will be required to pay fees for performance of inspections.

STUDY FINDINGS

Comparison of Emissions Reduction Benefits

The level of emissions reduction resulting from I/M depends upon the size of the motor vehicle population covered by the I/M program. Indiana has chosen to investigate three levels of geographic coverage. Hence, there are three levels of motor vehicle coverage under the six alternatives analyzed in this report.

Alternatives 1 and 6 provide statewide I/M coverage. They involve the largest motor vehicle population possible. Consequently, they will attain the largest HC and CO reductions for Indiana.

Alternatives 2, 3 and 4 establish mandatory I/M within a seven-county area. Alternative 5 provides coverage in the same seven-county area as well as in portions of five urbanized areas lying outside the nonattainment areas.

These alternatives provide a lower level of program coverage than is possible with the statewide alternatives. Thus, emissions reductions resulting from alternatives 2 through 5 will be correspondingly smaller than reductions realizable with alternatives 1 and 6. Alternatives 2, 3 and 4 cover the smallest vehicle population, so their potential emission reductions are the lowest of the six alternatives analyzed in this report. The possible reductions for alternative 5 fall between this minimum and the reductions that result from a statewide mandatory I/M program.

HC and CO emission reductions have been calculated using the EPA Mobile I computer routine. Emission reductions in 1987 for the various alternatives appear in Table 1.

Comparison of Personnel Requirements

Table 2 summarizes personnel requirements associated with the six alternatives analyzed in this report. In addition to personnel directly involved in administrative positions and as employees of contractors for alternatives 1, 2, 3, 4, 5 and 6, the personnel requirements for mechanics employed by the CSIS network are presented.

A CSIS mechanic workforce that is equivalent to 761 full-time workers is necessary to perform existing safety inspections statewide, regardless of whether or not an I/M emissions testing program is implemented. This figure is reported for all alternatives so that the trade-off between contractor employees and CSIS mechanics can be observed. In alternative 4 a decline in CSIS mechanics performing safety inspections results when safety inspections are performed at contractor operated facilities in the seven nonattainment counties.

Comparison of Costs

Two separate types of emissions inspection networks are discussed in this report. Emissions inspections are performed at either contractor facilities or at certified state inspection stations. The extent of geographic coverage of these networks varies across alternatives.

Two types of costs are associated with CSIS network operation. There is the actual cost of performing an emissions inspection at a CSIS. In addition, the state must maintain and operate a fleet of surveillance and calibration vans to assure quality control and meet minimum EPA requirements. CSIS cost figures are reported in Table 3 and the annual costs of running the surveillance fleet (referred to as "emission sticker fee") are reported in Table 4. The emission sticker fee is calculated to cover state administrative expenses, making the program self-supporting.

For comparative purposes, CSIS safety inspection costs are also included in the report. The current program will continue in all alternatives except alternative 4. The cost of safety inspection is $4.00 for the CSIS (a 15-minute inspection at $16.00 per hour) plus $0.50 for the safety sticker fee.

TABLE 1. SUMMARY OF HYDROCARBON AND CARBON MONOXIDE EMISSIONS (kg/day)

				Alternatives 2, 3, 4			Alternative 5			Alternatives 1, 6		
Area	1975	1982	1987 Without I/M	1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M	1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M	1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Hydrocarbons												
Allen County	28,011	15,508	9,055	6,612	76.4	27.0	6,612	76.4	27.0	6,419	77.1	29.1
Clark County	13,368	7,805	4,721	3,649	72.7	22.7	3,649	72.7	22.7	3,567	73.3	24.4
Floyd County	5,272	3,362	2,207	1,650	68.7	25,2	1,650	68.7	25.2	1,622	69.2	26.5
Lake and Porter Counties	60,298	38,878	24,122	19,249	68.1	20.2	19,249	68.1	20.2	19,145	68.2	20.6
Marion County	102,962	59,941	36,949	28,195	72.6	23.6	27,980	72.8	24.2	27,169	73.6	26.5
St. Joseph County	29,827	15,260	8,467	6,025	79.8	28.8	5,673	81.0	33.0	5,929	80.1	29.9
Remainder of State	563,932	362,616	233,198	231,628	58.9	0.7	230,229	59.2	1.3	171,004	69.7	22.3
Statewide	803,670	503,370	318,720	297,008	63.0	6.8	295,042	63.3	7.4	234,855	70.7	26.3
Carbon Monoxide												
Allen County	205,691	144,588	88,489	56,992	72.3	35.6	56,992	72.3	35.6	54,509	73.5	38.4
Clark County	100,270	71,335	46,469	31,735	68.4	31.7	31,735	68.4	31.7	30,625	69.5	34.1
Floyd County	40,819	31,354	21,671	14,146	65.3	34.7	14,146	65.3	34.7	13,756	66.9	36.5
Lake and Porter Counties	592,067	460,323	277,799	212,658	64.1	23,4	212,644	64.1	23.4	211,255	64.3	24.0
Marion County	877,261	609,294	361,721	258,861	70.5	28.4	258,861	70.5	28.4	246,414	71.9	31.9
St. Joseph County	231,206	149,915	80,563	53,251	76.9	33.9	52,688	77.2	34.6	52,177	77.4	35.2
Remainder of State	3,860,327	3,354,665	2,484,718	2,465,019	36.1	0.8	2,446,771	36.6	1.5	1,673,513	56.7	32.6
Statewide	5,908,000	4,820,480	3,361,430	3,092,662	47.6	8.0	3,073,851	48.0	8.6	2,282,249	61.4	32.1

TABLE 2. SUMMARY OF PERSONNEL ANNUAL MAN-YEARS

Level of employment	Alternative					
	1	2	3	4	5	6
Administrative*	6	6	13	13	13	13
Regional administrative*	-	-	20	20	24	24
Contractor facility personnel	-	-	220	987	214	214
CSIS quality assurance personnel	124	46	-	-	10	86
Total direct program personnel	130	52	253	1,020	261	337
(CSIS mechanics) emissions†	254	101	-	-	13	159
(CSIS mechanics) safety‡	761	761	761	457	761	761
Total direct and indirect personnel	1,145	914	1,014	1,477	1,035	1,257

*For alternatives 1 and 2, a minimum number of state administrative personnel (APCD) are included. It is assumed here for comparison that existing safety program administrative personnel will oversee the I/M program.

†Assumes a mechanic works 2000 hours per year.

‡Personnel performing the current CSIS safety inspections (761) are already in place. This figure is presented to illustrate the impacts on personnel requirements that result when safety inspections are shifted to a contractor-run facility in alternative 4.

TABLE 3. SUMMARY OF CSIS FEES (1978 DOLLARS)

	Alternative 1 (statewide) ($)	Alternative 2 (7 counties) ($)	Alternative 5 (7 counties not in U.A.) ($)	Alternative 6 (part of state not in U.A.) ($)
Safety	4.00 + 0.50*	4.00 + 0.50*	4.00 + 0.50*	4.00 + 0.50*
Emissions				
With paid emissions retest	2.38	2.15	2.03	2.48
With free emissions retest	3.09	2.79	2.63	3.22
Total-Safety and Emissions				
With paid emissions retest	6.88	6.65	6.53	6.98
With free emissions retest	7.59	7.30	7.13	7.72

*CSIS safety inspection includes free reinspection per current policy. Costs are $4.00 for the CSIS plus $0.50 for the safety sticker.

TABLE 4. SUMMARY OF ANNUAL STATE AND CONTRACTOR COSTS AND FEES (1978 DOLLARS)

Annualized costs	Alternative 1 emissions sticker fee (statewide)	Alternative 2 emissions sticker fee (7 counties)	Alternative 3 contractor's fee (7 counties)	Alternative 4 contractor's fee (7 counties)	Alternatives 5 and 6 contractor's fee (5 urbanized areas)	Alternative 5 emissions sticker fee (nonurbanized portions of 7 counties)	Alternative 6 emissions sticker fee (part of state not in urbanized areas)
With i = 0.03*							
I. Annualized Capital Costs							
1. Land	-	-	101,000	216,000	99,000	-	-
2. Buildings	-	-	577,000	1,231,000	564,000	-	-
3. Equipment	196,000	71,000	693,000	2,438,000	681,000	15,000	136,000
II. Annualized Startup Costs	715,000	262,000	711,000	1,162,000	728,000	56,000	497,000
III. Annual Operating Costs	3,001,000	1,084,000	4,395,000	16,784,000	4,281,000	230,000	2,087,000
IV. Annual Administrative Costs	107,000	107,000	1,044,000	948,000	1,015,000	-	-
Total Annual Cost	4,020,000	1,525,000	7,425,000	22,779,000	7,368,613	301,000	2,719,000
Fee f_c With Paid Emissions Retest	0.66	0.63	3.05	9.37	3.22	1.03	0.72
Fee f_c With Free Emissions Retest	0.86	0.82	3.96	12.18	4.19	1.34	0.93
With i = 0.06*							
I. Annualized Capital Costs							
1. Land	-	-	203,000	433,000	198,000	-	-
2. Buildings	-	-	749,000	1,598,000	733,000	-	-
3. Equipment	213,000	77,000	754,000	2,650,000	741,000	16,000	148,000
II. Annualized Startup Costs	777,000	285,000	775,000	1,264,000	792,000	61,000	540,000
III. Annual Operating Costs	3,001,000	1,084,000	4,395,000	16,784,000	4,281,000	230,000	2,087,000
IV. Annual Administrative Costs	107,000	107,000	1,053,000	948,000	1,015,000	-	-
Total Annual Cost	4,099,000	1,554,000	7,820,000	23,676,000	7,759,000	307,000	2,774,000
Fee f_c With Paid Emissions Retest	0.67	0.64	3.22	9.74	3.39	1.05	0.73
Fee f_c With Free Emissions Retest	0.87	0.83	4.19	12.66	4.41	1.37	0.95

*i = interest rate in absence of inflation.

Contractor operated facility costs are summarized in Table 4 for alternatives 3, 4, 5, and 6. They are used to derive "contractor fees" which are designed to cover all contractor costs.

Table 4 reports cost information for two different interest rates in the absence of inflation. Appendix E, "Detailed Description of Cost and Fee Calculations" describes the cost calculations and how to adjust the fees to account for inflation.

Figures 4 and 5 combine all the above costs. For each alternative, the total cost per inspection (with free reinspection) is presented for each geographic area of the state. Costs are presented for interest rates of 3 and 6 percent in the absence of inflation. All figures are in 1978 dollars. Thus, for any year after 1978, all costs must change at a rate equal to inflation.

Discussion of Potential Externalities and Political Issues

In addition to the primary benefits of reducing motor vehicle exhaust emissions inspection/maintenance programs have other indirect or secondary impacts. These impacts are externalities that originate during program implementation.

Potential political implications arising from these impacts may hinder legislative approval. In an attempt to identify key issues at an early stage, I/M programs existing in other states have been examined as well as the alternatives under consideration for Indiana. Early acknowledgment of any potential problem areas, coupled with actions to alleviate them, can avert more serious difficulties later.

The findings of research into these issues appear in Section 9, "Externalities: Indirect Impacts," and Section 10, "Legislative Considerations in I/M Implementation." Findings specific to each individual alternative appear in the appropriate sections 3 through 8.

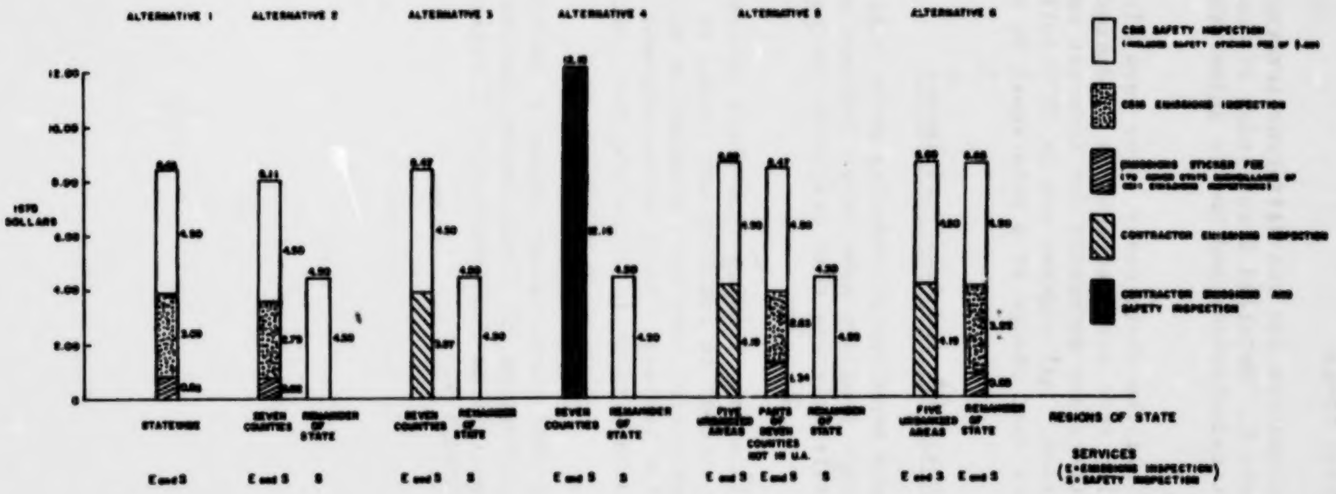


Figure 4. Summary of fees with free reinspection and i = 0.03 (i = interest rate in absence of inflation).

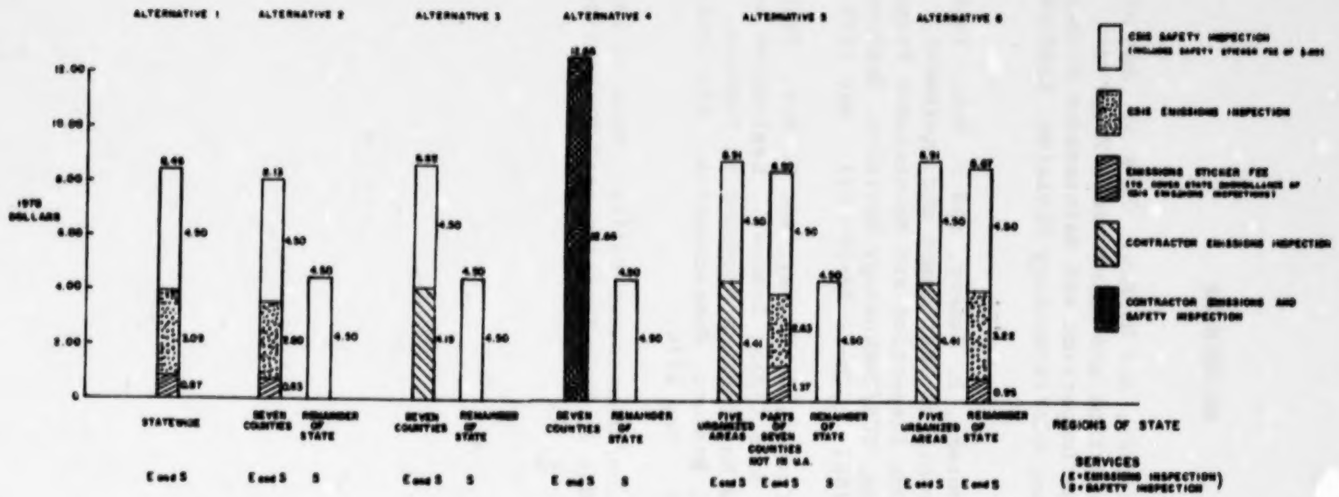


Figure 5. Summary of fees with free reinspection and i = 0.06
(i = interest rate in absence of inflation).

REFERENCES

1. Vlasak, D. L., T. P. Midurski, and N. Roy. Task A: Summary Report on Vehicle Emissions Inspection and Maintenance Programs. Evaluation of Motor Vehicle Emission Inspection and Maintenance Programs for Indiana. GCA Corporation, GCA/Technology Division, Bedford, Massachusetts. July 1978.

2. Vlasak, D. L., T. P. Midurski, D. Ramsay, and N. Roy. Technical Memorandum No. 2 - Ownership of Test Lanes and Equipment. Evaluation of Motor Vehicle Emissions Inspection and Maintenance Programs in Indiana. GCA Corporation, GCA/Technology Division, Bedford, Massachusetts. EPA Contract No. 68-02-2887. GCA-TR-78-29-G(2). May 1978.

3. Vlasak, D. L., T. P. Midurski, D. Ramsay, and N. Roy. Technical Memorandum No. 3 - Test Mode (Idle, Loaded). Evaluation of Motor Vehicle Emissions Inspection and Maintenance Programs in Indiana. GCA Corporation, GCA/Technology Division, Bedford, Massachusetts. EPA Contract No. 68-02-2887. GCA-TR-78-29-G(2). May 1978.

4. Hawkins, D. G. Inspection/Maintenance Policy. Memo to Regional Administrators, Regions I through X, U.S. Environmental Protection Agency, Ann Arbor, Michigan. 1978. p. 4.

SECTION 1

INTRODUCTION

BACKGROUND

Need for Inspection/Maintenance

Amendments to the Clean Air Act that were adopted during 1977 have established that the National Ambient Air Quality Standards (NAAQS) for pollutants such as carbon monoxide (CO) and photochemical oxidants (O_x) must be attained in all areas of the U.S.A. no later than 31 December 1982. The Amendments also require that each state submit a revised State Implementation Plan (SIP) during January 1979 demonstrating compliance by 31 December 1982. That all states will not be able to demonstrate total compliance by the end of 1982 is recognized in the Amendments and provisions are made for extending the compliance date to 31 December 1987. In order to obtain the extension, however, the revised SIP to be submitted in January 1979 must include (among other things) a specific schedule for the implementation of a motor vehicle emissions inspection and maintenance (I/M) program in those nonattainment areas that have an urbanized population greater than 200,000. Failure to submit an acceptable I/M schedule (or if a reasonable effort toward submitting an acceptable schedule is not being made) will result in rather severe sanctions being imposed on the state.

Background of this Study

Data used to report the status of air quality control regions in the State of Indiana, have indicated that certain of the NAAQS will not be achieved by 31 December 1982. Given the requirements of the Clean Air Act Amendments mentioned above, a decision was made to initiate action that would serve to identify the overall requirements for I/M in the State. This action involved the designation of the Air Pollution Control Board (APCB) as the overall policymaking body, and the designation of the Air Pollution Control Division of the Indiana State Board of Health (APCD-ISBH) as technical advisor to the APCB in matters relating to its policy decisions. Also, professional services were obtained from a private contractor to assist the APCB in connection with the evaluation of the HC and CO reduction potential of an I/M program.

Initially, the APCB, with the assistance of the APCD-ISBH, requested from the contractor a summary of available program designs. Background data regarding technical and administrative aspects of I/M programs as well as a summary of the experiences of various states which have already developed I/M programs were developed and provided through a series of technical memoranda and a summary report. The basic purpose of this task was to provide state officials who are responsible for development of the SIP revisions and the I/M program with somewhat general technical and nontechnical information. This could serve as a basis for making preliminary decisions regarding the selection of certain specific I/M program alternatives to be investigated further.

Based in part on the data provided, the APCB, in its meeting of 24 May 1978, selected six such I/M program alternatives for study. Each of the six alternative approaches were to be evaluated with the intent of providing the technical staff of APCD-ISBH with a comparative analysis. This comparative analysis would be in terms of costs, benefits, and other considerations and requirements. The details and results of this analysis are presented in this report.

What are Inspection and Maintenance Programs?

Prior to discussing specific details regarding inspection and maintenance (I/M) program issues in Indiana, a general discussion of the basic concepts of I/M are in order.

Beginning with 1968 model-year vehicles, automobiles manufactured in or imported into the U.S.A. have had to comply with emission standards specified in the Federal Motor Vehicle (emission) Control Program (FMVCP). Under this program, maximum emission rates are established for new vehicles, and manufacturers must demonstrate through an auditing program that their vehicles are in compliance with these emission limits. The emission standards specified by the FMVCP require progressively more stringent control of emissions with each subsequent model year.

To comply with the emission standards, manufacturers have retained their existing engine design concepts, but developed emission control devices (crankcase ventilation control, catalytic converters, etc.) and revised certain system parameter specifications (air-to-fuel ratio, ignition timing, etc.). This approach to emission control ostensibly satisfied the requirements of the FMVCP for new vehicles. However, surveillance studies conducted by EPA disclosed that the emission rate for these "controlled" vehicles generally increased with time at a much greater rate than was expected, therefore reducing greatly the overall effectiveness of the FMVCP. Further analyses determined that the root causes of the rapid deterioration of these emission control systems could be traced to either improper or inadequate maintenance, or tampering with the devices or system settings.

In light of these findings, effort has been expended on developing techniques for reducing the air quality impact of poor maintenance practice and tampering. One result of this effort is the evolution of the inspection and maintenance concept.

In its most basic sense, inspection and maintenance is a program in which vehicle emission levels are measured during specified operating conditions, and compared with standards for that particular vehicle configuration. If the measured level is greater than the standard, the need for some form of maintenance, adjustment or repair is indicated. This is a very simplistic explanation of I/M, but it does serve to define the concept involved. A more precise discussion of various technical aspects of I/M may be found in the background report preceding this document entitled "Summaru Report on Vehicle Emissions Inspection and Maintenance Porgrams.[1]

I/M Program Decision Variables

The establishment of an I/M program requires decisions to be made concerning a variety of program characteristics. Depending on certain policy decisions reached regarding these characteristics, an I/M program can take a variety of different forms. The six I/M program alternatives selected for evaluation here differ from one another primarily in terms of three decision variables: ownership and operation of test facilities, type of emissions test performed, and geographic coverage. Each of these decision variables is discussed below.

Ownership and Operation of Test Facilities--

An important decision which the state must make in selecting an I/M program concerns the ownership and operation of test lanes and equipment. (This issue has been discussed in detail previously in Technical Memorandum No. 2.[2] The reader is also referred to the material in Sections 3 through 8 of this document, in which the six program alternatives are described and evaluated in detail.) The two main types of organizational structures which Indiana has chosen for conducting I/M programs are:

1. Contractor: Centralized facilities operated by a private corporation under contract to the state (as in Arizona and California); and

2. Certified State Inspection Stations (CSIS): Decentralized facilities (garages, service stations, or new car dealerships) operated by private individuals and certified or licensed by the state (as in Rhode Island and Nevada).

In addition to these primary types, there may be combinations, as seen in many of the alternatives chosen by Indiana. For example, alternative 6 combines a contractor approach for five urbanized areas with the certified state inspection stations in the remainder of the state.

Each of the two organizational approaches has advantages and disadvantages. The contractor approach allows for greater accuracy in testing, better quality assurance, and better consumer protection, but incurs higher capital costs. The certified state inspection station approach, if properly planned, may offer greater consumer convenience but, due to the lack of separation between the inspection and maintenance function, may offer less consumer protection. Also, there may be problems in quality assurance due to variability in testing equipment and calibration practices. The costs and benefits of the two approaches are discussed in detail in Sections 3 through 8.

Type of Emissions Test--

Another important issue in inspection/maintenance programs concerns the type of emissions testing (idle or loaded mode) performed. A detailed discussion of testing procedures may be found in Reference 3. Basically, the idle-mode test consists of measuring exhaust gases from the vehicle in neutral gear at idle speed and/or at high idle (usually 2500 rpm). The loaded mode makes use of a chassis dynamometer so that emissions can be measured during simulated driving conditions. Generally, the accuracy of the idle test is approximately equal to that of the loaded test in identifying gross emitters, but the loaded test provides better diagnostic information and can measure nitrogen oxide (NO_x) emissions, which the idle test cannot. Indiana has chosen to investigate both test types in the six alternatives.

Geographic Coverage--

The geographic coverage refers to the area included in the jurisdiction of an I/M program. The primary reason for inclusion or esclusion of an area in I/M program coverage has to do with the local motor vehicle population and its relative concentration, as these are the primary components which determine the severity of the air pollution problem.

The U.S. EPA has issued guidance to the states concerning minimum standards for geographic coverage. In an EPA memorandum entitled "Inspection/Maintenance Policy" dated 17 July 1978, David G. Hawkins, Assistant Administrator for Air and West Management, issued the following statement concerning geographic coverage:

> "I/M should focus on metropolitan areas and should include the entire urbanized area and adjacent fringe areas of development. Boundaries of the area affected may be adjusted if an equivalent emission reduction is achieved. For urbanized areas of 200,000 population or greater which need I/M to obtain an extension of the 1982 attainment date, full mandatory I/M must be implemented by December 31, 1982 for new centralized programs, and December 31, 1981 for all other programs. Statewide programs are encouraged, especially for those states which are small and highly urbanized.
>
> It should be emphasized that all nonattainment areas must have SIP's which are adequate to attain and maintain the National Ambient Air Quality Standards (NAAQS) by 1982 or by no later than 1987 should an acceptable nonattainment demonstration be made. For areas under 200,000, EPA will not at this time automatically require I/M schedules in 1979 as a condition for SIP approval or an extension. However, areas under 200,000 still have to attain and maintain NAAQS as expeditiously as practicable, and I/M is encouraged as a means of helping to provide for an adequate SIP. EPA will review the need for I/M in areas under 200,000 after the 1979 SIP revisions are submitted, and will consider additional requirements at that time."[4]

In the six program alternatives chosen for evaluation, the APCB has stipulated three different forms of geographic coverage, which are defined as follows:

- Five urbanized areas: In Indiana, there are four urbanized areas having populations equal to or greater than 200,000: these are Gary-Hammond, South Bend-Elkhart, Fort Wayne, and Indianapolis. For completeness, the Indiana portion of the Louisville, Kentucky urbanized area has also been included in this designation. The boundaries of these five urbanized areas as drawn by their respective metropolitan planning organizations (MPO's) have been designated I/M program limits for this type of geographic coverage. The five MPO's and their urbanized areas are:
    - Northwestern Indiana Regional Planning Commission (Gary-Hammond)
    - Michiana Area Council of Governments (South Bend-Elkhart)
    - Northeastern Indiana Regional Coordinating Council (Fort Wayne)
    - Department of Metropolitan Development (Indianapolis)
    - Kentuckiana Planning and Development Agency (Louisville)
- Seven nonattainment counties: Seven Indiana counties have been declared by the U.S. EPA to have nonattainment status with regard to ambient CO and O_x levels. Five of these counties contain urban populations of 200,000 or greater; the two Indiana counties containing the Louisville, Kentucky suburbs have also been designated as I/M areas for this type of program coverage. The seven counties include:
    - Lake and Porter Counties (Gary-Hammond)
    - St. Joseph County (South Bend)
    - Allen County (Fort Wayne)
    - Marion County (Indianapolis)
    - Clark and Floyd Counties (Louisville)
- Statewide: In this type of program coverage, all areas of the State of Indiana are included.

Other I/M Program Factors

The six program alternatives selected by the APCB for evaluation contain certain constant factors, viz:

Inspection Frequency--
Emissions inspections are to be performed annually. In order to avoid overburdening inspection facilities, inspections will be staggered throughout the year.

Stringency Factor--

Failure criteria for measured HC and CO levels will be established such that approximately 30 percent of those vehicles tested will fail and hence will need to undergo maintenance and reinspection.

Vehicle Categories to be Inspected--

Vehicles to be inspected in the I/M program include: (a) all light-duty gasoline-powered motor vehicles (LDVs) except those less than one year old or greater than 13 years old (based on model year); and (b) all light-duty gasoline-powered trucks (LDT) with a gross vehicle weight (GVW) of 8,500 pounds or less.

Inspector and Mechanic Training--

Individuals performing either inspection or maintenance functions under the I/M program will be required to participate in a state-sponsored training course, in which the objectives of the program, as well as inspection, maintenance, and repair techniques are explained.

Lead Agency--

The Air Pollution Control Division of the Indiana State Board of Health (ISBH-APCD) is to exercise overall administrative control of the I/M program. As noted in Sections 3 through 8, which detail each of the specific alternatives, ISBH-APCD may be assisted in its administrative duties by other state departments working under cooperative agreements. For alternatives 1, 2, 5 and 6, emissions inspections will be carried out in conjunction with the existing safety program presently administered by the Department of Traffic Safety. For this reason, at the state level the organizational network is conservatively defined.

Enforcement--

Enforcement for each of the six 1/4 program alternatives will be exercised through the motor vehicle registration process. While at present annual safety inspection is mandatory in Indiana and is enforced through registration, sticker ticketing is also employed. Any police officer authorized to enforce Indiana's motor vehicle laws may, any time, upon reasonable cause, issue a written repair notice to the owner of a vehicle believed to be defective and so require proper maintenance, along with written notification of such action. However, since motor vehicle registration is a legal prerequisite to vehicle operation and other than operating a vehicle illegally, tampering or forging forms are the only other means of demonstrating compliance, registration generally proves to be the superior approach. In Indiana the Commissioner of Motor Vehicles is authorized to suspend or revoke, as well as refuse to register, any Indiana vehicle subject to safety inspection for which a required certificate of inspection and approval has not or cannot be obtained. It is assumed that the registration procedure is flexible enough to accommodate any change which may be required to enforce I/M in the future.

Safety Inspection--

The existing motor vehicle safety inspection program will continue either in conjunction with or in addition to the I/M program, depending on the program alternative eventually selected. In general, certified state safety inspection stations are the privately-owned establishment licensed by the Indiana Bureau of Motor Vehicles to inspect vehicles, and in this report will be referred to as "Certified State Inspection Stations" (CSIS). There are currently approximately 4,600 such stations licensed to perform inspections. Statistical information concerning this CSIS network, as well as estimates of its future behavior, were provided by the Indiana Vehicle Inspection Department, Department of Traffic Safety and Vehicle Inspection.

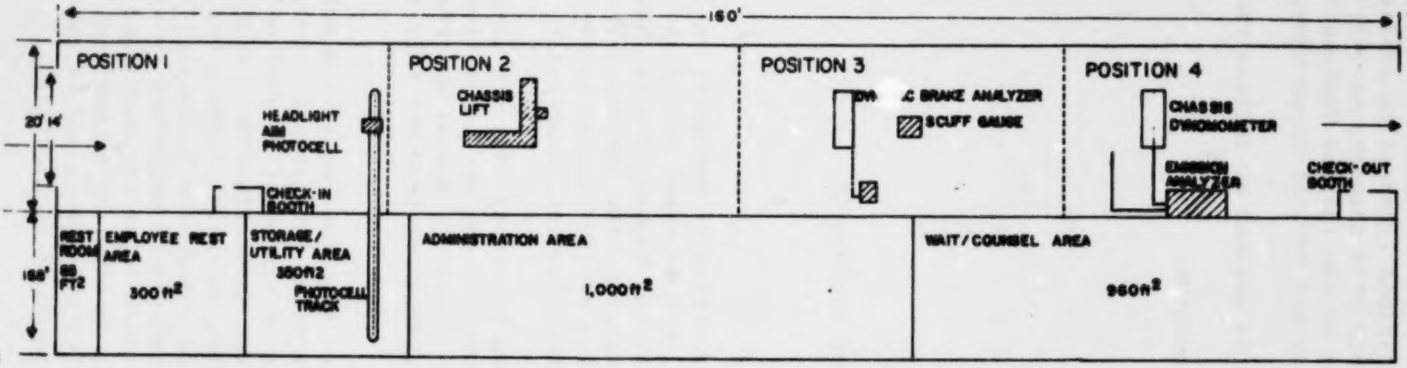
The safety inspection procedure is assumed to include the following items:

- Steering - Alignment - Suspension
- Brakes
- Tires and wheels
- Lighting equipment
- Horn
- Mirrors
- Windshield wipers
- Muffler and exhaust system
- Safety glass (safety glazing equipment)
- General body condition
- Emission control devices

Standards and procedures for inspection of hydraulic service brake systems, steering and suspension systems, and tire and wheel assemblies of motor vehicles in use have been set forth by the National Highway Traffic Safety Administration, United States Department of Transportation (NHTSA).[6] These standards are intended to serve as guidelines for the various states to use in establishing inspection criteria for their own safety inspection programs.

Indiana's safety program compares favorably with the established NHTSA rules and regulations. Items of inspection and the inspection procedures themselves, published in the Indiana Inspection Manual and the Federal Regulation, are similar.[5] The estimated throughput time for CSIS safety inspections is 15 minutes.

Alternatives involving contractor-operated facilities and requiring either the performance of safety inspection functions in conjunction with emissions inspections or the capacity to expand to include safety inspection functions in conjunction with emissions inspections will rely on the published Indiana safety inspection requirements, modified slightly for performance as individual tasks within lanes of these inspection facilities. Figure 1 diagrams the conceptual approach. Tasks to be performed in each position in an inspection lane are identified by item to be inspected and performance time. This schematic diagram has been based on existing states' and contractor's experience. Total performance time for the safety and emissions inspection tasks (or residence time) is estimated to be 20 minutes.


160'
POSITION I
POSITION 2
POSITION 3
POSITION 4
20' 14'
18.8'
HEADLIGHT AIM PHOTOCELL
CHECK-IN BOOTH
CHASSIS LIFT
DY...C BRAKE ANALYZER
SCUFF GAUGE
CHASSIS DYNOMOMETER
EMISSION ANALYZER
CHECK-OUT BOOTH
REST ROOM 88 FT2
EMPLOYEE REST AREA
300 ft²
STORAGE/ UTILITY AREA
350ft2
PHOTOCELL TRACK
ADMINISTRATION AREA
1,000 ft²
WAIT/COUNSEL AREA
960ft²

POSITION 1

TASK	ΔT (MIN)
CHECK-IN	1.0
LIGHTING SIGNALING	0.3
HEADLIGHT AIM	0.3
HORN	0.1
MIRRORS WIPERS	1.0
BODY/GLAZING	0.5
WHEELS	1.0
2 INSPECTORS	4.2MIN

POSITION 2

TASK	ΔT (MIN)
LIFT-UP	1.0
UNDERBODY (VISUAL)	2.0
·BALL JOINTS ·LINKAGE ·I-BEAM AXLE ·MOTOR MOUNTS ·SHOCKS ·SPRINGS/SHACKLES	
LIFT DOWN	1.0
1 INSPECTOR	4.0 MIN

POSITION 3

TASK	ΔT
DYNAMIC BRAKE TEST	3.0
TIRE INSPECTION	1.5
2 INSPECTORS	4.5 MIN

POSITION 4

TASK	ΔT
LASH, JAMMING	1.0
EMISSION ANALYSIS	2.2
CHECK-OUT	1.0
2 INSPECTORS	4.2 MIN

INTERSTATION MOVE 0.2 MINUTES

INTER STATION MOVE 0.2 MINUTES

INTER STATION MOVE 0.2 MINUTES

TOTAL TEST AREA = 3,200 ft²
TOTAL NONTEST AREA = 2,695 ft²
TOTAL BUILDING AREA 5,895 ft²

TOTAL RESIDENCE TIME 17.5 MINUTES
MINIMUM OF 7 INSPECTORS

Figure 1. Schematic diagram of contractor-operated test lane combining emissions and safety inspections.

Funding--

The I/M program will be entirely self-supporting with motorists required to pay fees for performance of inspections.

PROGRAM ALTERNATIVES

The Indiana Air Pollution Control Board (APCB) has selected six specific I/M program alternatives for analysis and evaluation. The six alternatives vary according to ownership of test facilities, test type, and geographic coverage; they have in common all the other program factors discussed above. A short description of each alternative follows:

- Alternative 1
  - Certified State Inspection Stations (private facilities) performing idle-mode emissions inspections, as well as the existing safety inspections, statewide.
- Alternative 2
  - Certified State Inspection Stations (private facilities) performing idle-mode emissions inspections, as well as existing safety inspections, in seven nonattainment counties.
  - Existing safety inspections performed by CSIS's in remainder of state. (See Figure 2.)
- Alternative 3
  - Contractor-operated emissions inspections independent of existing safety inspections in seven nonattainment counties. Idle-mode emissions inspections with capacity to expand to include safety inspections.
  - Existing safety inspections performed by CSIS's statewide. (See Figure 2.)
- Alternative 4
  - Contractor-operated combined loaded-mode emissions and safety inspections in seven nonattainment counties.
  - Existing safety inspections (no emissions inspections) performed by CSIS's in remainder of state. (See Figure 2.)
- Alternative 5
  - Contractor-operated emissions inspections independent of existing safety inspections in five urbanized areas.

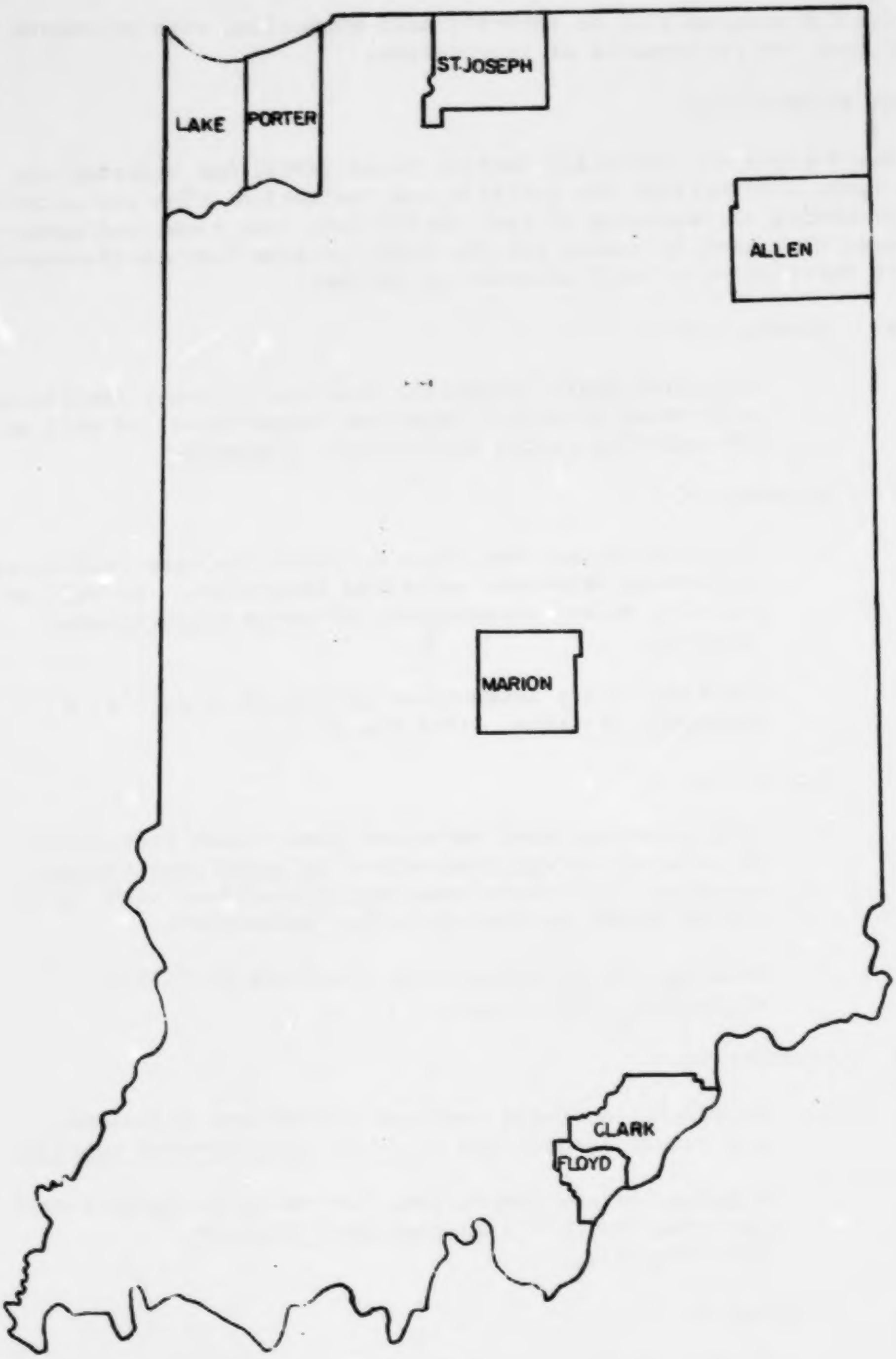

LAKE
PORTER
ST.JOSEPH
ALLEN
MARION
CLARK
FLOYD

Figure 2. The location of the seven nonattainment counties in Indiana.

Idle-mode emissions inspections with capacity to expand to include safety inspections.

  - Certified State Inspection Stations (private facilities) performing idle-mode emissions inspections as well as existing safety inspections in nonurbanized portions of the seven nonattainment counties.

  - Existing safety inspections (no emissions inspections) performed by CSIS's in remainder of state. (See Figure 3.)

- Alternative 6

  - Contractor-operated emissions inspections independent of existing safety inspections in five urbanized areas. Idle-mode emissions inspections with capacity to expand to include safety inspections.

  - Certified State Inspection Stations (private facilities) performing idle-mode emissions inspections as well as existing safety inspections in remainder of state. (See Figure 4.)

BASIS AND ORGANIZATION OF THIS REPORT

The basic intent of this report is to provide a comparative analysis of the six I/M program alternatives which have been outlined above, The approach taken in this report focuses on identifying the costs, benefits, and personnel requirements of each of the six program alternatives and developing comparisons among them. To familiarize the reader with the methodologies by which these costs, benefits, and personnel requirements were derived, a detailed discussion of the procedures followed is provided in Section 2. The discussion encompasses: (1) relevant motor vehicle population projections; (2) derivation of contractor-operated network requirements; (3) capital, operating, and administrative cost requirements; (4) consumer protection/quality assurance requirements; (5) personnel requirements; (6) total cost calculations; (7) fee determinations; (8) emissions reduction benefits; and (9) derivation of CSIS network requirements.

Sections 3 through 8 discuss the specific alternatives themselves with regard to costs, benefits, consumer protection mechanisms, enforcement, quality assurance, possible externalities, legislative considerations, and personnel requirements. The discussion is straightforward and alternative specific in each of these sections, although it is based to a large extent on the methodologies defined in Section 2. The methodologies discussed in Section 2 are referenced extensively. In the following sections, the reader will be referred back to Section 2 repeatedly where appropriate.

Section 9, "Possible Externalities: Indirect Impacts," and Section 10, "Legislative Considerations in I/M Implementation," deal with two important questions in evaluating the six alternatives and their potential impacts.

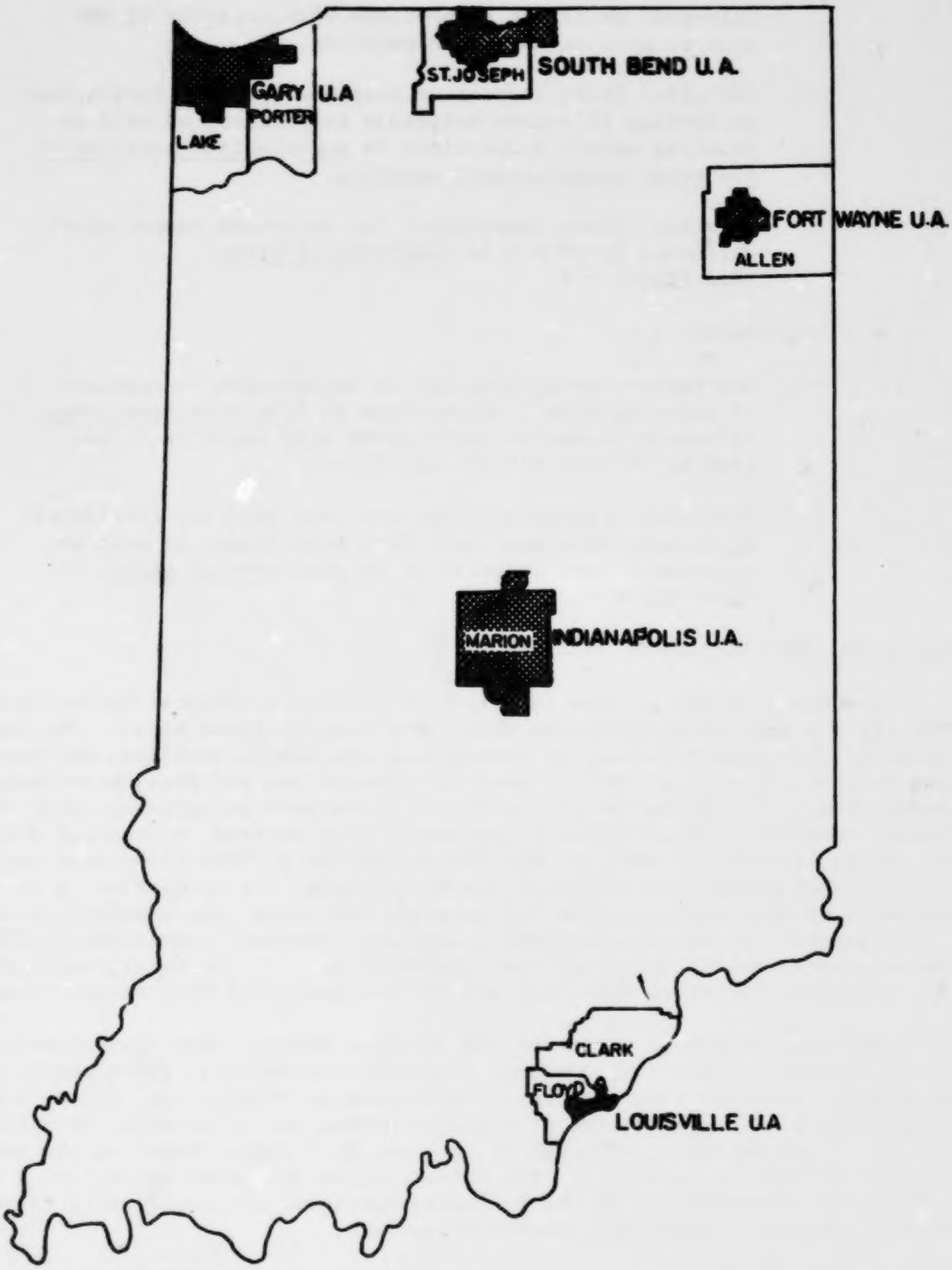

SOUTH BEND U.A.
ST.JOSEPH
GARY U.A
PORTER
LAKE
FORT WAYNE U.A.
ALLEN
MARION
INDIANAPOLIS U.A.
CLARK
FLOYD
LOUISVILLE U.A

Figure 3. The location of nonurbanized portions of the seven nonattainment counties in Indiana.

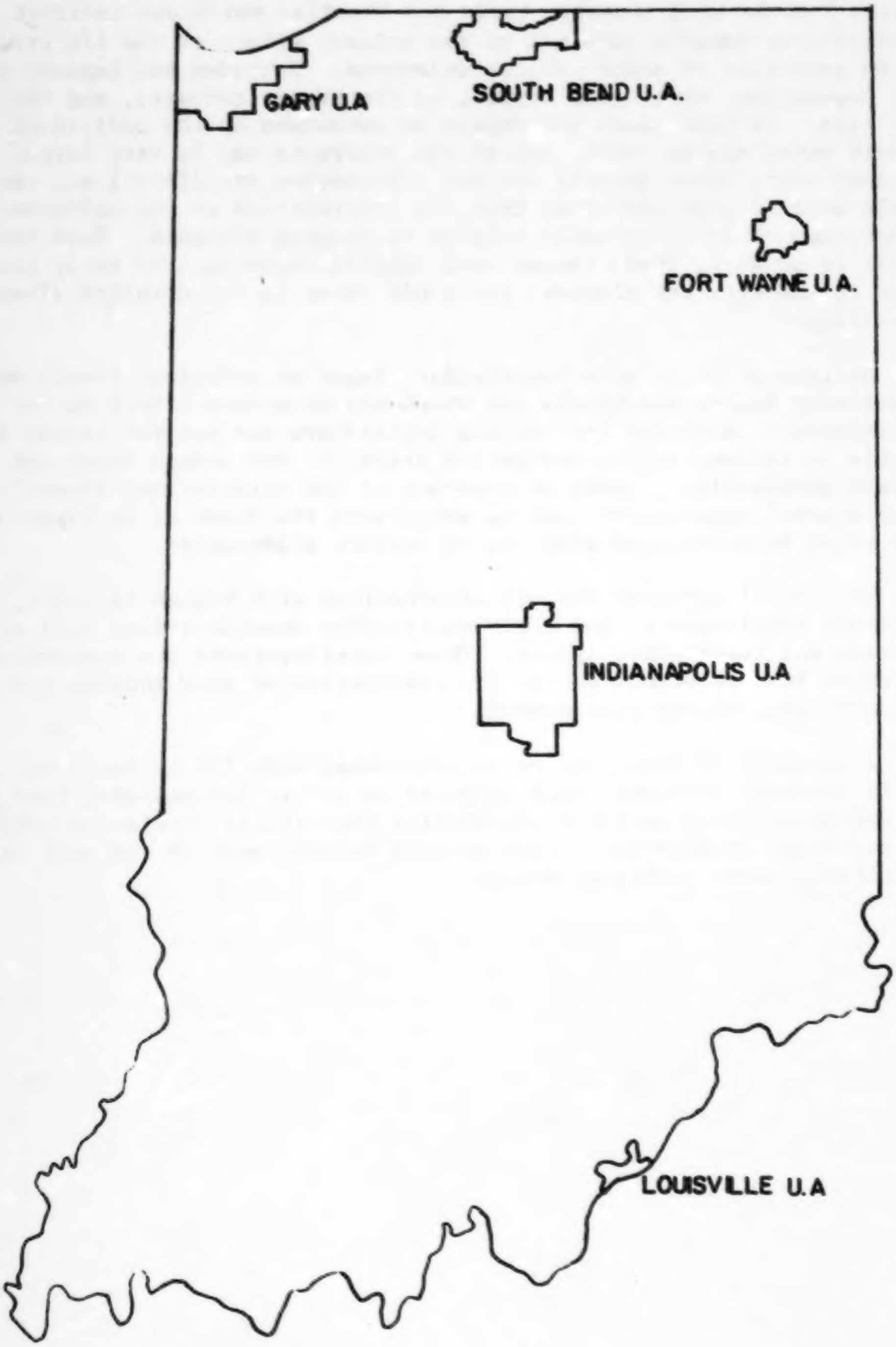

GARY U.A
SOUTH BEND U.A.
FORT WAYNE U.A.
INDIANAPOLIS U.A
LOUISVILLE U.A

Figure 4. The location of the five urbanized areas considered for an I/M program in Indiana.

Section 9 deals with impacts, costs and benefits which are indirect, secondary, cumulative or somehow external to the primary effect of the I/M program, which is the reduction of motor vehicle emissions. Included are impacts on the general population, on vehicle owners, on the repair industry, and the impacts of test type. In some cases the impact as perceived by the individual citizen or vehicle owner may be small, but in the aggregate may be very large. Also, for the most part, these impacts are not alternative specific; i.e., they either result more or less uniformly from all alternatives or the differential effect is not measurable nor clearly related to program elements. Even though difficult to measure, these issues need clarification at this early planning stage to identify key elements for study later in the detailed alternative evaluation.

Section 10 deals with legislative, legal or political issues which may potentially become roadblocks and which may adversely affect one or several alternatives. Although the Indiana legislature has not yet become involved in this early comparative evaluation stage, it was deemed important to offer certain perspectives, based on analysis of the alternatives themselves and other states' experiences, and to anticipate the types of problems or issues that might be associated with one or another alternative.

Section 11 compares the six alternatives with regard to costs, benefits, personnel requirements, and other qualitative considerations such as externalities and legislative issues. These considerations are summarized and presented in a reference matrix for information on each Indiana I/M alternative by appropriate page number.

A Glossary of technical terms associated with I/M is included. Finally, in the Appendix sections, such subjects as public information, fuel savings, and the methodology used for calculating the vehicle population projections and emissions inventories - only briefly touched upon in the main text - are described in more technical detail.

REFERENCES

1. Vlasak, D. L., T. P. Midurski, and N. K. Roy. Task A: Summary Report on Vehicle Emissions Inspection and Maintenance Programs. Evaluation of Motor Vehicle Emission Inspection and Maintenance Programs for Indiana. GCA Corporation, GCA/Technology Division, Bedford, Massachusetts. July 1978.
2. Vlasak, D. L., T. P. Midurski, D. Ramsay, and N. K. Roy. Technical Memorandum No. 2 - Ownership of Test Lanes and Equipment. Evaluation of Motor Vehicle Emissions Inspection and Maintenance Programs in Indiana. GCA Corporation, GCA/Technology Division, Bedford, Massachusetts. EPA Contract No. 68-02-2887. GCA-TR-78-29-G(2). May 1978.
3. Vlasak, D. L., T. P. Midurski, D. Ramsay, and N. K. Roy. Technical Memorandum No. 3 - Test Mode (Idle, Loaded). Evaluation of Motor Vehicle Emissions Inspection and Maintenance Programs in Indiana. GCA Corporation, GCA/Technology Division, Bedford, Massachusetts. EPA Contract No. 68-02-2887. GCA-TR-78-29-G(2). May 1978.
4. Hawkins, D. G. Inspection/Maintenance Policy. Memo to Regional Administrators, Regions I-X, U.S. Environmental Protection Agency, Ann Arbor, Michigan. 1978. p. 4.
5. State of Indiana "Rules and Regulations and Inspection Manual." Department of Traffic Safety and Vehicle Inspection. p. 67.
6. Vehicle In-Use Standard. Title 49 - Transportation Chapter V - NHTSA, DOT. Docket No. 73-9, Notice 2. Part 570. Issued August 29, 1973.

SECTION 2

METHODOLOGIES

INTRODUCTION

Sections 3 through 8 of this report evaluate six inspection/maintenance I/M alternatives specified by the State of Indiana. An analytical methodology has been developed to identify important criteria and study the various aspects of these criteria within the six alternatives. The primary criteria identified and dealt with are costs, benefits, and personnel requirements; there are additional considerations associated with these. They include issues of consumer protection, program enforcement, quality assurance, legislation, and externalities or issues of secondary or indirect impact.

The purpose of this section is to present the methodologies used in deriving criteria useful in performing comparative analysis. Population projection methods, contractor and certified state inspection station (CSIS) network derivations, and the costing methodology for both contractor and CSIS network facilities are described for each of the six alternatives in simple and explicit detail. Isolating the methodologies used and presenting them separately, allows the reader to concentrate on the results of the analysis of each alternative without needless repetition of data and formulae.

MOTOR VEHICLE POPULATION PROJECTIONS

Before the costs of establishing a motor vehicle I/M program in Indiana can be calculated, reasonable estimates of the motor vehicle population to be served by such a program must be derived. The Clean Air Act Amendments of 1977 mandate that states containing areas not attaining federal air quality standards in 1982 must, as a minimum, implement I/M within these noncompliance areas. If a good faith effort on the part of the state in question is demonstrated in meeting national ambient air quality standards (NAAQS), this deadline may be extended to 1987. The motor vehicle populations in 1982 and 1987 are therefore of interest to administrators of an emissions inspection program.

I/M established in this situation should accommodate inspection needs in 1987. Adjusting a 1987 vehicle population figure to account for reinspections and using it to design network facilities for 1982 assures sufficient capacity for the first 5 years of program operation, at least, and without incurring additional expenses.

The size of the motor vehicle populations to be inspected depends upon the geographic coverage of the program alternative selected. In the first four alternatives, program coverage is either statewide (alternative 1) or for the seven nonattainment counties (alternatives 2, 3, and 4). Alternatives

5 and 6, however, establish a contractor run emissions only network in five urbanized areas. Thus, in addition to statewide and seven-county requirements, motor vehicle population projections must be broken down into urbanized and rural components for 1987.

A detailed discussion of the projection methodology employed appears in Appendix G. Projections are based on 1975 population statistics. Population growth rates were calculated and applied to the 1975 estimates to project them 7 and 12 years into the future to arrive at 1982 and 1987 estimates.

The results of this process are presented in Table 1. Inspection facility networks for the various alternatives were designed to accommodate future needs based upon the figures reflected here. Base data and growth rate calculations appear in Appendix G along with the complete description of the projection methodology.

DETERMINATION OF THE CONTRACTOR RUN NETWORK

For alternatives 3 through 6 a private contractor will construct and operate centralized facilities designed to meet the specific requirements of an emissions inspection program. The techniques used to derive the contractor facility network emphasize speedy and convenient service. Facilities are kept small to provide a larger number of locations for the consumer to choose from. They are large enough, however, to take advantage of the potential efficiencies of larger facilities.

Within each county or urbanized area, the I/M facilities must be capable of providing enough inspections to cover the entire vehicle population that is included in the program. Since the facility networks are designed to meet 1987 inspection demand, the system will not become overburdened during the initial years it is in operation. In designing facilities, 8 daily hours of operation and a 40-hour work week were assumed in conformance with existing state experience. Should future demand dictate an increase in capacity, operating hours can easily be extended to accommodate the additional vehicles.

Lane Requirements

Dividing the demand for inspections in each county in 1987 by the annual capacity of an inspection lane determines how many lanes are needed in each county.

Lane capacity is determined by the length of time a vehicle spends at the slowest position in the lane (the throughput time). For an idle-mode emissions test actual emissions inspection takes the longest time - a 2-minute throughput. A combined safety and loaded-mode emissions inspection lane has a 4.5 minute throughput, as one position in the lane combines a dynamic brake test with tire inspection, taking 4.5 minutes to complete. The idle test lane has an hourly capacity of 30 vehicles while the combined loaded-mode emissions testing and safety inspection lane has an hourly throughput of 13.3 vehicles.

TABLE 1. MOTOR VEHICLE INSPECTIONS REQUIRED, 1982 AND 1987

Area	Inspections required 1982 Urban	1982 Rural	1987 Urban	1987 Rural
Indianapolis				
Marion County	758,680	0	887,592	0
Johnson County	31,607	43,337	40,990	56,204
Hamilton County	24,226	56,134	32,544	74,855
Louisville				
Clark County	50,447	39,036	62,310	48,218
Floyd County	39,437	18,411	45,878	21,419
South Bend				
St. Joseph County	191,677	35,001	216,455	39,504
Elkhart County	62,972	74,543	76,008	89,976
Fort Wayne				
Allen County	250,895	55,930	303,544	67,694
Gary-Hammond				
Lake County	482,026	35,277	553,979	40,544
Porter County	52,876	57,257	69,568	75,332
Statewide	5,181,696		6,086,496	

Source: GCA calculations, 1978.

Annual lane capacity is calculated by multiplying hourly throughput by 40 hours by 52 weeks. This figure should be adjusted by an efficiency factor of 0.67 to account for the random arrival of vehicles at an inspection facility, possible downtime, etc. For idle-mode emissions testing only, annual lane capacity is 41,808 vehicles and for a combined loaded-mode emissions test and safety inspection lane, annual capacity is 18,535 vehicles.

CONTRACTOR NETWORK COST CONSIDERATIONS

Two separate methodologies are used in calculating network costs. The first method is used to evaluate state and contractor costs for the six I/M alternatives analyzed in this report. A second method is used to derive the costs of a certified state inspection station (CSIS) network for alternatives 1, 2, 5 and 6. The contractor network cost methodology is discussed here and the CSIS network cost methodology is developed later in this section.

The contractor network cost methodology focuses on four basic cost categories:

- Initial capital costs
- One-time startup costs
- Annual operating costs
- Annual administrative costs

These categories are broken down into their component parts in Table 2. Breaking down costs into basic components allows the reader to develop a feel for the costs of various I/M program elements. The element costs can also be compared across alternatives.

All the costs of items appearing in Table 2 are reported in 1978 dollars. Inflation is assumed to be nonexistent at this stage of the analysis. A detailed discussion of how the cost components are calculated follows.

Initial Capital Costs

Initial capital costs are the initial outlays required for real property and equipment purchases. These costs are very sensitive to the type of program selected and the specific features incorporated into a particular alternative. There are three types of initial capital costs.

Land Investments--

Land investment capital cost outlays are a product of the square foot cost of land and the total area required. After the contractor network has been specified, the total land area it requires can be calculated. At this stage of analysis, an exact dollar figure cannot be used. A number of factors are extremely critical in estimating land costs. First, the price of land per square foot is lot-specific. Land costs may vary by a factor of 3 within any block and by a factor of 10 within any city or town. Also, it is possible that no parcel of land of adequate size exists in an area for which a facility has been specified.

TABLE 2. OUTLINE OF PROGRAM COST CATEGORIES AND ELEMENTS

Primary category	Principal Element	Items included
I. Initial Capital Costs	1. Land investment	a. Actual land cost
		b. Pavement and landscaping
	2. Building investment	a. Construction cost
	3. Equipment costs	a. Primary test equipment
		b. Ancillary equipment
		c. Office equipment/furnitures
		d. Maintenance equipment
II. One-Time Start-Up Costs	1. Land acquisition	a. Site location studies
		b. Title transfer costs
	2. Facilities planning	a. Design study
		b. Bid evaluation
		c. Construction monitoring
	3. Program design	a. Develop equipment specifications
		b. Develop subprograms (e.g., public information, surveillance, quality control, enforcement, etc.)
		c. Define personnel organizational structure
		d. Define data handling needs
		e. Plan program effectiveness studies
	4. Develop data handling systems software	
	5. Personnel training	a. Inspectors
		b. Managers
		c. Quality control personnel
	6. Personnel salaries and overhead prior to start-up	
	7. Initial public information program	
III. Annual Operating Costs	1. Facility personnel	a. Wages, benefits, etc.
	2. Maintenance; calibration costs	a. Equipment
	3. Utilities/services/supplies	a. Electric
		b. Heat
		c. Insurance
		d. Miscellaneous
		e. Taxes
IV. Annual Administrative Costs	1. Program administrative personnel	a. Wages, overhead
	2. Enforcement	
	3. Consumer protection/quality Assurance	
	4. Public information	
	5. Training, licensing, certification	

Based on the general requirements of the alternatives being analyzed (e.g., lot size, configuration, access, zoning, etc.), cost estimates were obtained from Indiana real estate sources. Estimates vary from $1.00 to $4.00 per square foot for a typical facility. For comparison in this phase calculations have been based on a $2.00 per square foot figure.

Lot size is viewed as being a function of throughput for a given facility. Facility size is allowed to vary according to population density and space requirements for vehicles, with certain constraints placed on the magnitude of this variation. Facilities are sited so as to try to assure that vehicle owners do not have to travel more than 10 to 15 miles to have their vehicle inspected. The maximum facility size considered is six lanes. Large facilities will be located in or near high density central city areas. Since land costs and acquisition difficulties are greatest in these areas, difficulties in locating or assembling plots of land suitable for larger facilities may arise. However, at the other extreme, no single-lane facilities were considered. One-lane facilities exhibit a low level of cost effectiveness resulting in a high cost per inspection.

Building size is a function of the number of lanes the building contains and the type of inspection taking place. The area required for each lane varies with the type of inspection it is capable of accommodating. Table 3 lists inspection type, number of positions, area required per position, and total lane area requirements.

Building area is comprised of the actual test area, an administrative section, an employee rest and relaxation area, storage and utility space, and restrooms. Four test types identified in Table 3 also incorporate a waiting/counseling area into the inspection facility.*

Facility lot size is calculated assuming a 5:1 lot to building ratio. The building size for all alternatives is derived assuming that safety inspection will be performed initially or at some future date. This approach provides flexibility; alternatives initially having no safety inspection are afforded the capability of expanding in the future without having to finance additional land or buildings.

Land improvement costs are included in the land investment figure. Paving and landscaping are the basic components considered. Paving requirements are based on the assumption that queue areas required for vehicles waiting to enter inspection lanes are 250 feet by 20 feet for each lane and that 135 square feet of parking is required per employee. Paving costs are assumed to be $0.80 per square foot and landscaping costs $0.25 per square foot.

---

*Formulae for calculating the area required by these components appear in "Time Saver Standards for Architectural Design Data," J. H. Callender, McGraw-Hill, 1974.

TABLE 3. LANE AREA REQUIREMENTS AS A FUNCTION OF TEST TYPE

Test type	Number positions/lane	Area/position (square feet)	Total area/lane (square feet)
Idle-mode emission only[*] - HC/CO emissions test using idle-mode HC/CO analyzer	3	500	1,500
Idle-mode emissions with waiting/counseling area[†] HC/CO emissions test using idle-mode HC/CO analyzer	3	500	1,500
Loaded-mode emissions only[†] - HC/CO/NO_x emissions test using HC/CO/NO_x analyzer and dynamometer	3	600	1,800
Safety and idle-mode emissions[†] - wheel alignment, HC/CO emissions, headlight alignment, tire scuff, visual and platform brake analysis	4	800	3,200
Safety and loaded-mode emissions[†] - wheel alignment, HC/CO/NO_x emissions, headlight alignment, tire scuff, visual and platform brake analysis	4	800	3,200

[*] Also includes administrative space, employee rest, storage and utility, and restroom areas.

[†] Also includes administrative space, employee rest, storage and utility, restroom areas and waiting/counseling area.

Source: GCA calculations, 1978.

Building Investments--

Building costs are obviously dependent upon specific design features; therefore, unit costs (in dollars per square foot) can be expected to vary somewhat. The general design description for contractor buildings specifies a clear span, metal structure, utilizing metal sandwich panel walls with normal wall and ceiling finish for the administrative areas and no wall or ceiling finish in the inspection area. Equipment such as an air exchanger and forced hot-air heaters in the inspection area and central heating and air-conditioning in the administrative areas is also included. No provisions are made for specialized systems like exhaust fume collectors, etc.; these expenses are included in the equipment costs.

A mid-1978 average building cost of $30.00 per square foot is used in calculating all contractor facilities. Yet, in developing an estimate of building costs for each alternative, the basic size of the building must first be defined.

An analysis of the specific inspection tasks (including equipment requirements) was made to define the general features required of an inspection facility. Literature searches and interviews with individuals involved with similar programs were conducted. The results of this effort were used to define specific building requirements and dimension the various work areas. A conceptual floor plan of the basic facility required for safety and emission testing is shown in Figure 5. While Figure 5 illustrates a one-lane facility, the total floor area for a multilane facility increases by the single inspection-area floorspace times the number of lanes in the facility. Additional space for waiting areas, rest areas, etc., is also required.

Equipment Costs--

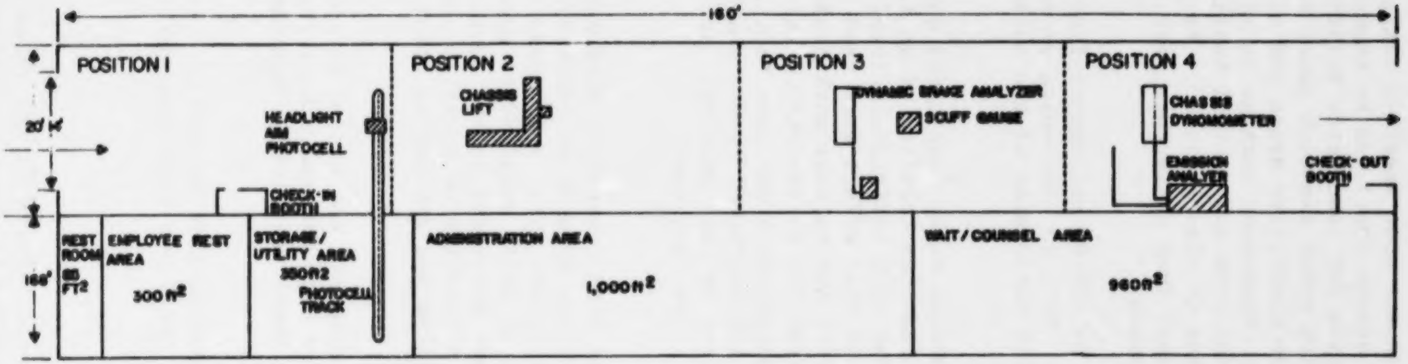
Equipment cost estimates developed from interviews with manufacturer's representatives are used. These interviews focused on identifying the major equipment items that are the most appropriate types and models for I/M purposes, and determining a general level of skill required to operate and maintain this equipment. Specific costs are presented in the sections devoted to each alternative. Equipment costs as a function of facility configuration (number of lanes per facility) are derived and applied to total network requirements.

Calibration vans and associated equipment are needed in addition to facility equipment. An estimated cost for each van and the calibration gases needed is $14,000. The total cost for these vehicles is dependent upon the network they must serve.

A centralized computer facility must be able to collect and analyze data gathered at the inspection facilities. Only one such computer is required for each alternative.

One-Time Startup Costs

Implementation of an I/M program will require expenditures for noncapital items and services on a one-time basis prior to the actual start of the program.


160'
20'
16'
POSITION I
HEADLIGHT AIM PHOTOCELL
CHECK-IN BOOTH
POSITION 2
CHASSIS LIFT
POSITION 3
DYNAMIC BRAKE ANALYZER
SCUFF GAUGE
POSITION 4
CHASSIS DYNOMOMETER
EMISSION ANALYER
CHECK-OUT BOOTH
REST ROOM 80 FT2
EMPLOYEE REST AREA 300 ft²
STORAGE / UTILITY AREA 350ft2
PHOTOCELL TRACK
ADMINISTRATION AREA 1,000 ft²
WAIT / COUNSEL AREA 960ft²

POSITION I

TASK	ΔT (MIN)
CHECK-IN	1.0
LIGHTING SIGNALING	0.3
HEADLIGHT AIM	0.3
HORN	0.1
MIRRORS WIPERS	1.0
BODY / GLAZING	0.5
WHEELS	1.0
2 INSPECTORS	4.2MIN

POSITION 2

TASK	ΔT (MIN)
LIFT-UP	1.0
UNDERBODY (VISUAL)	2.0
·BALL JOINTS ·LINKAGE ·I-BEAM AXLE ·MOTOR MOUNTS ·SHOCKS ·SPRINGS / SHACKLES	
LIFT DOWN	1.0
1 INSPECTOR	4.0 MIN

POSITION 3

TASK	ΔT
DYNAMIC BRAKE TEST	3.0
TIRE INSPECTION	1.5
2 INSPECTORS	4.5 MIN

POSITION 4

TASK	ΔT
LASH, JAMMING	1.0
EMISSION ANALYSIS	2.2
CHECK-OUT	1.0
2 INSPECTORS	4.2 MIN

INTERSTATION MOVE 0.2 MINUTES

INTER STATION MOVE 0.2 MINUTES

INTER STATION MOVE 0.2 MINUTES

TOTAL TEST AREA = 3,200 ft²
TOTAL NONTEST AREA = 2,695 ft²
TOTAL BUILDING AREA 5,895 ft²

TOTAL RESIDENCE TIME 17.5 MINUTES
MINIMUM OF 7 INSPECTORS

Figure 5. Conceptual floor plan for a combined safety and loaded-mode emission inspection facility.

Costs in this category are difficult to determine at this point because they involve services (program planning, design and development) which are inherently more variable than even equipment and land costs. This problem is further intensified because the specific scope of these services is unknown. The elements that make up one-time startup costs are described below.

Land Acquisition--

Land acquisition costs reflect the effort required to locate and evaluate candidate sites, perform required surveying, negotiate price and convey title. Locating and purchasing land will require roughly 200 man-hours of professional technical time, at $20 per hour, and 40 hours of professional legal time, at $50 per hour for each site. This represents a cost of $6,000 per site. Title transfer costs include physical surveys, title searches, site plan preparation and miscellaneous support functions needed to execute a purchase. These costs are estimated at 10 percent of the purchase price of land.

Facilities Planning--

Engineering and design costs, bid review and construction monitoring costs are included in this element. This cost is estimated as a function of total building cost for each alternative. For building costs under $3 million, facilities planning costs are calculated as 20 percent of construction costs. This figure drops to 15 percent for building costs of $3 million to $6 million, and to 10 percent for building costs over $6 million.

Program Design--

This element reflects the cost of additional planning studies required to establish specific formats for the operation and administration of both the actual inspection program as well as associated programs such as public information. These costs are also likely to be quite variable; the extent of in-house effort by the state and other factors will affect them. The relative cost will vary between alternatives. The experiences of other states were used to complement our analysis in estimating this cost.

Data Handling Software--

Regardless of the option selected for implementation, a data software package will be required to provide both basic recordkeeping and program analysis functions. For contractor facilities with fully automated data handling capabilities and minicomputers, representatives of several computer companies were consulted as well as companies who have interphased diagnostic emission testing equipment with computerized data handling systems. An average cost of $200,000 was estimated for a centralized system.

Personnel Training--

Although personnel training will require an ongoing program, the initial phases of such an effort are the most crucial. General acceptance of I/M is more likely if it is phased-in gradually, beginning with a voluntary maintenance stage. This approach helps the training effort by allowing a longer period of time to fully train all the personnel.

In alternatives 3, 4, 5, and 6, the contractor would devise his own methods for providing inspectors and managerial personnel independent of the state. To the extent that this lessens state commitments regarding both training personnel and inspectors, this approach may be quite attractive.

If the centralized contractor approach is used, the training costs for instructors, investigators and inspector/mechanics are $53.00, $43.00 and $16.00, respectively (see Table 4). A private contractor would be likely to incur costs in this range, or slightly lower. The lower cost reflects the fact that the contractor is using his own facility for training, as well as his own personnel for instruction.

Personnel Salaries--

The literature and information obtained from interviews with both officials from states with existing I/M programs and private contractors involved in I/M indicate that for centralized programs, the managerial, support, and technical personnel should be phased into the program prior to the initiation of any inspections. This phase-in would bring managerial personnel in 6 months prior to startup, while inspectors would begin 1 month before any mandatory phase. Support personnel would become familiar with their specific job functions and general procedures. The phase could include mandatory inspection/voluntary maintenance. This would provide a realistic working environment but without the stress of maintaining a rather rigid production schedule as required during the full mandatory phase. It would serve as a "shakedown" period for the equipment and test procedure as well.

The personnel cost of the first six months of operation, then, is included in the one-time startup cost category for operations personnel (technical, managerial, and support) for centralized facility alternatives.

The state administrative personnel function would begin 18 months prior to startup for the contractor-operated centralized facility alternatives.

Cost calculations for personnel salaries are based on the following assumptions:

- all managerial personnel will be phased into the program 6 months prior to startup
- inspectors will be phased in 1 month prior to startup
- managerial wage scale is $15,000 per annum
- assistant manager's wage scale is $13,000 per annun
- maintenance/calibration personnel wages are $12,000 per annum
- inspector wages are $9,000 per annum.

TABLE 4. ESTIMATED INSTRUCTION COST FOR INSTRUCTOR, INVESTIGATOR, AND INSPECTOR/MECHANIC TRAINING[*]

Expenditure items	Personnel training requirements					
	Contractor approach			Certified state inspection station approach		
	Instructor[†] ($)	Investigator[†] ($)	Inspector/ mechanic[‡] ($)	Instructor[†] ($)	Investigator[†] ($)	Inspector/ mechanic[‡] ($)
Rent, insurance, utilities	40	40	12	150	150	45
Equipment	120	120	50	150	150	60
Teaching supplies	150	150	110	120	120	110
Instructor	590	390	100	900	600	180
Clerical	160	160	50	160	160	50
Total	1060	860	322	1,480	1,180	445
Cost per person	53	43	16	74	59	22

(continued)

---

[*] High Altitude Vehicular Emission Control Program, Volume VIII. Pilot Training Program Results for Motor Vehicle Emission Control, Supplement II. August 1976. Colorado State University and GCA estimates.

[†] One 40-hour training class.

[‡] One 12-hour training class.

TABLE 4 (continued).

ASSUMPTIONS:

- There are 20 students per class.
- There is one instructor per class, except where instructors are teaching instructors. Here, the recommended student/teacher ratio is 12:1; so the indicated cost is for 1.5 instructors.
- A $600.00 maximum figure is used for rent per month (this includes insurance and utilities). When this is broken down into smaller time periods, the rate is considered to be somewhat increased. If a building is owned or rent-free (as certified state inspection stations may be), this figure would change. It is assumed that, in the centralized approach, the contractor already owns the building.
- The equipment cost given for the certified state inspection stations is a cost-to-rent figure. If the equipment had already been purchased, the cost would change. It is assumed that in the centralized approach, the equipment has been purchased. Therefore, this figure would only encompass electrical costs.
- The instructor cost for the centralized approach is the cost of a manager's time.
- For the centralized approach, it is assumed that one lane would be used, and safety and emissions testing would be taught.
- The teaching supplies are Colorado State University material, and would vary according to what has already been purchased by those in this field in Indiana.
- The clerical costs will vary according to the extent of records kept as well as whether a testing system is used.

Public Information Program--

The experience thus far with I/M program operation shows that there is a definite requirement for a rather vigorous public information effort prior to program startup. While there are no specific requirements defined regarding necessary leadtime, program content, or budget, the general experience indicates that it would be reasonable to expect that efforts should begin anywhere from 6 to 12 months prior to startup, and that a preimplementation budget based on a $0.12 per vehicle inspected figure is warranted. These general assumptions were used in deriving an estimate of the initial public information program requirements for Indiana. Consequently, there will be variations among the alternatives because the vehicle population varies. Public Information Programs are discussed in Appendix C.

Annual Operating Costs

Annual operating costs include all costs associated with the actual operation of the program. For present purposes, the costs of adjunctive programs such as ongoing public information and inspector/mechanic training programs are not included; rather, the costs associated with these programs are included under the heading Annual Administrative Costs.

Facility Personnel--

Annual determinants of costs associated with the operation of the inspection facilities are (1) the total number of employees and relative level of job responsibility, and (2) the per-unit personnel cost including both wages and overhead.

In computing personnel costs for each alternative, the actual number of employees required by skill level was based upon the specific level of work effort associated with the particular alternative. Per-hour wage rates for various categories were derived from average state figures obtained from the Indiana Department of Administration's Personnel Division, with one notable exception - the station manager's duties specified for study purposes included considerably more functions than those listed for the most comparable state position. Specifically, the station manager would be required to be involved in many aspects of highly automated computer operation. For this reason, the station manager's salary is assumed to be 25 percent higher than the comparable state salary classification. Overhead estimates were based on data from the U.S. Department of Labor and state data, and from conversations with private contractors involved in operating I/M programs. The hourly overhead rate was determined to be 25 percent of the basic hourly wage rate.

Maintenance--

Costs associated with equipment maintenance and replacement were based on the experience of other states. It was found that these costs represent approximately 20 percent of the original equipment costs.

Calibration Costs--

The costs for calibration of emission analyzers are composed of the calibration/maintenance technicians' salaries, the calibration runs, annual operating expenses for the runs (fuel, maintenance, insurance, etc.) plus the cost of calibration gases. The first two elements are discussed under operating personnel costs and equipment costs, respectively. The annual insurance and fuel costs were assumed to be $1,000 each, and the cost of calibration gases was obtained from a supplier.

Utilities/Services/Supplies--

Included in this element are costs associated with electricity, heat, water, building services, office supplies, inspection forms and other miscellaneous items. They were estimated based on several sources' estimates of equipment and facility power requirements. Manufacturer's representatives, as well as the general literature and utility rate schedules, were consulted. Average heating, insurance and building services requirements for existing facilities were also examined.

Electricity costs are assumed to be $0.04 per kWh. A lane that performs emissions testing only uses 120 kWh per day while a lane that performs combined safety and emissions testing consumes 166 kWh per day. In addition, each facility will consume 325 kWh per day for nonlane requirements.

Contractor facilities will have to carry liability and property insurance. Based on the experience of other states, it will cost approximately $1,500 per lane per annum.

Computer operation costs for the centralized data facility have been estimated at $0.15 per test based on the experience of other states. Forms will cost $0.03 per test.

The cost of equipment calibration is recurring and defined as the cost of calibration gases plus the operating cost of the maintenance/calibration vans. These costs are calcualted in each alternative section.

The annual cost for general property taxes is calculated based on the tax rate for each municipality in which facilities are to be located. Tax information was obtained from the Indiana Board of Tax Commissioners.

Based on the experience of other states, an annual cost of $125.00 per uniformed employee for uniforms is assumed.

Security system costs are again based on the experience of other states. They are assumed to run $850.00 per lane per annum.

The annual cost of operating Complaints Investigators cars is $1,500, based on a $0.15 per mile cost and an annual average of 10,000 miles travelled.

Annual Administrative Costs

Annual administrative costs include all costs associated with the overall management of the I/M program. They include the salaries of all state and/or contractor administrative personnel above the station level, as well as the ongoing costs of adjunctive programs. Adjunctive programs are used to keep the inspection process running smoothly. They are public information, enforcement, consumer protection/quality assurance, and inspector training.

Administrative Personnel--

The annual cost of administrative personnel is computed based on comparison of existing State of Indiana job descriptions with salary classifications as defined for each of the required I/M positions. A complete listing of these administrative positions, with job descriptions for each, can be found in the section entitled "Personnel Requirements."

Public Information--

An annual public information program cost of $0.12 per vehicle inspected is used. A detailed discussion of this estimate can be found in Appendix C. It should be emphasized, however, that this cost changes, not only with the extent of the public relations campaign itself and with the number of vehicles tested, but with the alternative chosen, as some alternatives will be much more difficult to present to the public than others.

Enforcement--

No cost has been assumed for enforcement of the I/M program, as the Indiana Bureau of Motor Vehicles and the Indiana State Police are already operating an enforcement program in connection with the existing safety inspection program. While it is possible that additional enforcement personnel will be required after implementation of an I/M program, it is impossible at this time to estimate the numbers of such personnel.

Consumer Protection/Quality Assurance--

Besides the annual costs of mobile state inspection and licensing officials, calibration technicians, and complaints investigators, no additional program costs have been assumed for consumer protection; it is assumed that the Vehicle Inspection Department of the State of Indiana is already operating an effective consumer grievance program in connection with the existing safety inspection program. No added personnel requirements will be considered at this time.

Inspector Training--

It is assumed that personnel at the station level will experience an annual turnover rate of 10 percent for the contractor-run alternatives. Thus, an ongoing inspector training program should educate an additional 10 percent of the total inspector work force annually. The cost of training an inspector, as discussed above, is $16.00.

TOTAL COST METHODOLOGY

In order to compare cost between various alternatives, the costs appearing in the cost summary tables for each alternative are converted into annual figures. Appendix E contains a complete description of the methodology used. The more salient points follow.

Initial Capital Costs

The elements of this capital cost category are found in Table 2. Costs will be incurred at the beginning of the project. These costs - expressed in constant 1978 dollars - are converted to annual figures - also in 1978 dollars - by use of amortization factors. Amortization factors are determined for each of the three subclasses of capital costs - land, structures, and equipment. Different amortization factors arise from the various life expectancies of the three kinds of investments.

Land yields services in perpetuity. Thus the amortization factor (or yearly cost of 1 dollar of land investment) is the marginal rate of return on capital, i. The marginal rate of return on capital is the interest rate in an economy without inflation. This rate ranges from 0.03 to 0.06 depending on the source of financing - equity, debt, or taxes.

Structures last 20 years and yield equal services during each year of their life. Thus the annual cost of each dollar invested in building is $\frac{1}{1-(1+i)^{-20}}$.

Equipment lasts 5 years and yields equal services for each of the 5 years. Thus, the annual cost of each dollar invested in equipment is $\frac{1}{1-(1+1)^{-5}}$.

One-Time Startup Costs

One-time startup costs, like capital costs, are incurred at the beginning of the project. The startup costs are recouped over the first 5 years of the project. Thus, the annual cost of each dollar of expenditure is the same as that for capital equipment, $\frac{1}{1-(1+1)^{-5}}$.

Annual Operating and Administrative Costs

These costs are already presented as annual amounts. These amounts must be added to the annualized capital startup costs, so as to arrive at the annual cost of the whole project.

Fee Calculations

A fee, f_c, is calculated by dividing total annual costs by the number of paid inspections per year. This fee, along with all other costs, is expressed in real 1978 dollars. To get figures in actual dollars for years other than 1978, costs and fees must be increased by the amount of inflation since 1978.

Interest rates used with real or constant dollar calculations reflect the real return on capital. Actual interest rates include compensation to offset the diminished buying power of money under inflation, and thus, are inappropriate here.

In the Appendices, another fee, (f_a), is presented. This fee is also expressed in 1978 dollars; however, it is uniform in actual dollars and will not increase with inflation for 5 years after the program begins.

PERSONNEL REQUIREMENTS

The basic requirements of an I/M program call for both operating and administrative personnel. Operating personnel are those directly involved in performing inspections or providing managerial functions at the inspection site. Administrative personnel are involved in operating support programs such as enforcement and quality control, or in providing overall program management and administration.

Operating Personnel

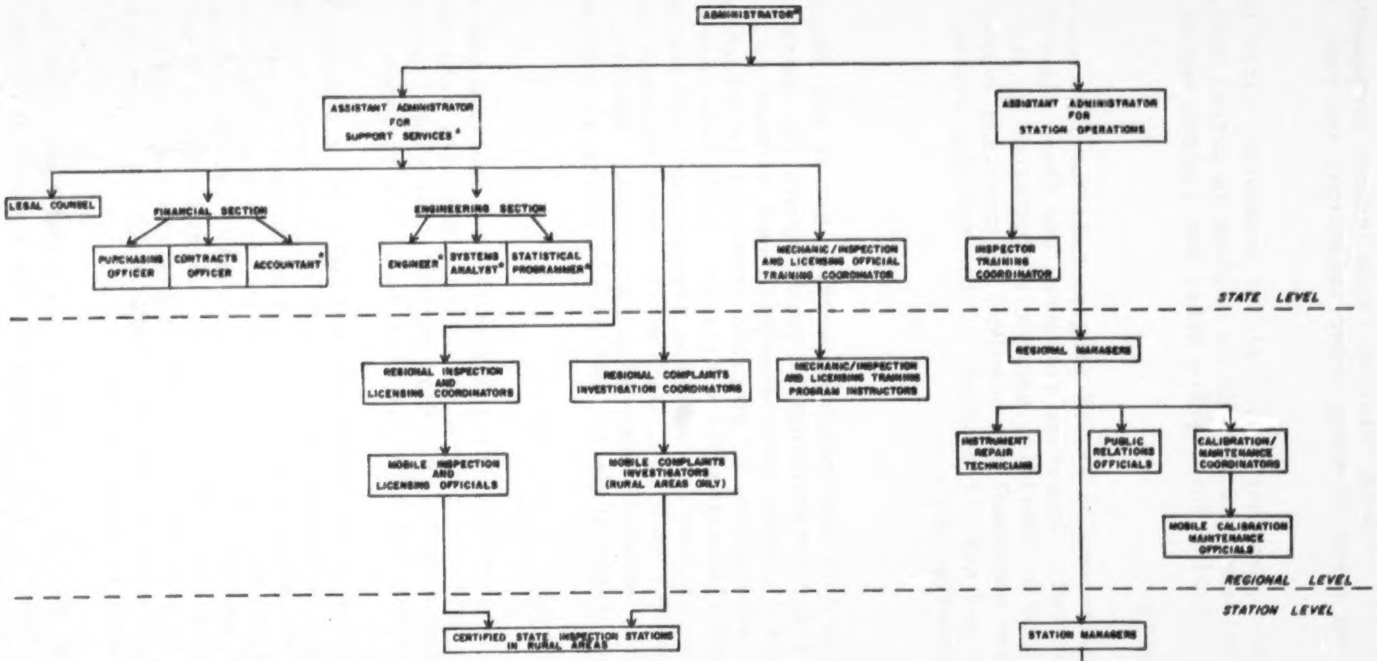
This category is more alternative specific than is the administrative category. The basis for determining the requirements for operating personnel include both analyses of tasks associated with each element of the program alternative and the experiences of programs currently in operation. In general, the manpower allocation for contractor facilities consists of (1) three inspectors per lane for emission inspections, (2) one manager and one assistant manager for each facility, and (3) one equipment maintenance person for every three emission inspection facilities. Specific manpower requirements for each alternative are delineated in the appropriate sections.

Administrative Personnel

A scenario of the administrative personnel requirements was developed based on the overall scope of each alternative, including geographic coverage and level of operational activity, other states' operational programs of a similar scope and nature, and previous studies of I/M programs.

A schematic diagram of an organizational network is presented in Figure 6. This figure indicates that the I/M program would be coordinated by an administrator who would oversee actions of supporting services and station operations sections. Each of these sections would be headed by a respective assistant administrator. The supporting services assistant, in addition to supervising the legal, financial, engineering, and mechanic training officers, would be responsible for assisting the administrator in policy decisions. The facility operations assistant would supervice regional managers for each of six regions, as shown in Figure 7.

The legal counsel position, probably handled either by the Indiana State Department of Public Health Legal Counsel or the Indiana Attorney General's Office, would assist the administrator in interpretation of any legal issues that might arise in the operation of the program.


ADMINISTRATOR*
ASSISTANT ADMINISTRATOR FOR SUPPORT SERVICES*
ASSISTANT ADMINISTRATOR FOR STATION OPERATIONS
LEGAL COUNSEL
FINANCIAL SECTION
PURCHASING OFFICER
CONTRACTS OFFICER
ACCOUNTANT*
ENGINEERING SECTION
ENGINEER*
SYSTEMS ANALYST*
STATISTICAL PROGRAMMER*
MECHANIC/INSPECTION AND LICENSING OFFICIAL TRAINING COORDINATOR
INSPECTOR TRAINING COORDINATOR
STATE LEVEL
REGIONAL INSPECTION AND LICENSING COORDINATORS
REGIONAL COMPLAINTS INVESTIGATION COORDINATORS
MECHANIC/INSPECTION AND LICENSING TRAINING PROGRAM INSTRUCTORS
REGIONAL MANAGERS
INSTRUMENT REPAIR TECHNICIANS
PUBLIC RELATIONS OFFICIALS
CALIBRATION/MAINTENANCE COORDINATORS
MOBILE INSPECTION AND LICENSING OFFICIALS
MOBILE COMPLAINTS INVESTIGATORS (RURAL AREAS ONLY)
MOBILE CALIBRATION MAINTENANCE OFFICIALS
REGIONAL LEVEL
STATION LEVEL
CERTIFIED STATE INSPECTION STATIONS IN RURAL AREAS
STATION MANAGERS
STATION PERSONNEL

*Cost estimates for alternatives 1 and 2 deal, conservatively, with only these state personnel. It is assumed that the other state level personnel will be shared with the existing safety program.

Figure 6. Administrative network.

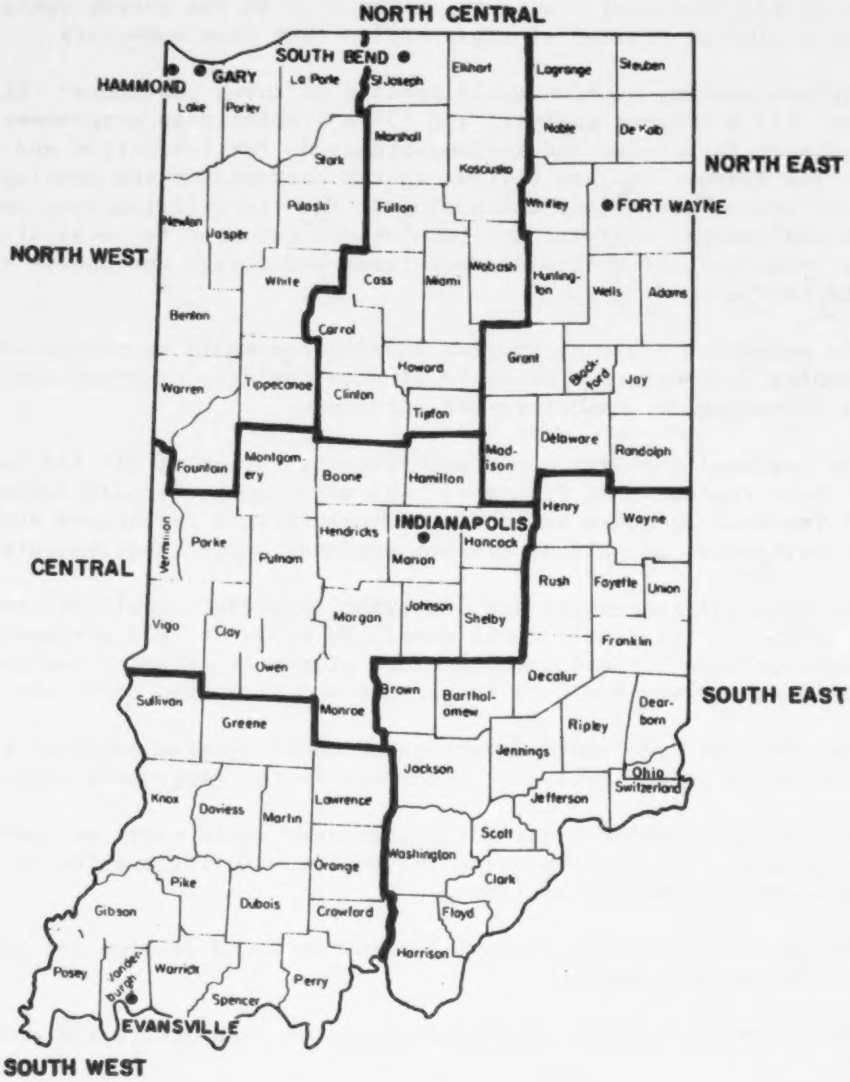

NORTH CENTRAL
SOUTH BEND
HAMMOND
GARY
NORTH EAST
FORT WAYNE
NORTH WEST
INDIANAPOLIS
CENTRAL
SOUTH EAST
EVANSVILLE
SOUTH WEST
Lake
Porter
La Porte
St Joseph
Elkhart
Lagrange
Steuben
Noble
De Kalb
Marshall
Stark
Kosciusko
Newton
Jasper
Pulaski
Fulton
Whitley
White
Cass
Miami
Wabash
Hunting-ton
Wells
Adams
Benton
Carroll
Howard
Grant
Black-ford
Jay
Warren
Tippecanoe
Clinton
Tipton
Delaware
Randolph
Fountain
Montgom-ery
Boone
Hamilton
Mad-ison
Henry
Wayne
Vermillion
Parke
Putnam
Hendricks
Marion
Hancock
Rush
Fayette
Union
Vigo
Clay
Owen
Morgan
Johnson
Shelby
Franklin
Decatur
Sullivan
Greene
Monroe
Brown
Barthol-omew
Dear-born
Ripley
Jennings
Jackson
Ohio
Switzerland
Jefferson
Knox
Daviess
Martin
Lawrence
Scott
Washington
Orange
Clark
Pike
Dubois
Gibson
Crawford
Floyd
Harrison
Posey
Vander-burgh
Warrick
Spencer
Perry

Figure 7. Six Indiana I/M administrative regions.

The financial section of supporting services would consist of three positions: (1) a purchasing officer, (2) a contracts officer, and (3) an accountant. The purchasing officer, in addition to handling actual acquisition of equipment and supplies, would be responsible for formulation of current and future budget requirements. The contracts officer would be responsible for negotiation and review of all contracts necessary to I/M system construction and operation. The accountant would be in charge of keeping records of all financial transactions involved in the system operation, possibly including receipt of registration fees from motorists.

The engineering section would consist of three positions: (1) a systems engineer, (2) a systems analyst, and (3) a statistician/programmer. The systems engineer formulates and reviews standards for inspection and stringency rates. The systems analyst reviews system performance and develops more efficient system operations methodology. The statistician/programmer would perform statistical analyses and tabulations required for evaluation of station, regional, or statewide operations and design and update software for data handling.

The mechanics training program coordinator would be responsible for hiring and training instructors. He would arrange training programs and devise tests for the licensing of inspectors and repairmen.

The regional managers would supervise operation of all I/M facilities within their regions (see Figure 7). In addition to overall administration, the I/M regional managers would direct surveillance operations and calibration of test equipment, as well as prepare regional budget requirements.

The regional inspection and licensing supervisor would be responsible for certification of repair facilities. He would be held responsible for the proper calibration and working order of repair industry analyzers. Serving under this supervisor would be inspection and licensing officials.

The regional complaints investigator would receive consumer complaints and carry out a proper grievance procedure in the geographic region.

The regional public relations coordinator would serve as spokesperson for the program. He would provide the public with information to assure participation in and support of I/M.

The mechanic training program instructor would develop and conduct classes and certification testing.

The instrument repair technician would be responsible for equipment repairs.

All of the above descriptions of administrative personnel apply to all the alternatives. Separate organizational networks will be provided in the alternative descriptions themselves to clarify differences in personnel requirements that are alternative specific. It should be emphasized, here, that the network of administrative personnel provided for and costed out in alternatives 1, 2, 5 and 6 (CSIS) differs from that for alternatives 3 through 6 where the contractor approach is involved in that cost calculations for the CSIS network are more conservative, providing for minimal state involvement. This does not detract sufficiently from the comparative nature of analysis at this level, however. Quite deliberately, the designation of a more complete administrative network is left to another stage of more detailed analysis where certain policy determinations have been made by the state.

EMISSION REDUCTION BENEFITS

Emission reduction benefits resulting from I/M program implementation are calculated using the Environmental Protection Agency's Mobile I computer program. Benefits are based on VMT figures for nonattainment areas, overall vehicle population, vehicle population breakdown by age, and other considerations. A detailed explanation of the methodology used appears in Appendix A.

DETERMINATION OF THE CERTIFIED STATE INSPECTION NETWORK

In presenting assumptions and calculations pertaining to a program of emissions inspections to be conducted by a network of certified state inspection stations (CSIS), it is useful to discuss first the motivations and constraints of an individual station, and then to discuss general relationships associated with a network of such stations. In the discussion below, it is assumed that the motor vehicle population to be tested is the same as that derived at the beginning of this section. Test stringency is again assumed to be 30 percent, so the number of inspections to be performed is the same as that derived previously under contractor network requirements.

Individual Station Behavior

The service station industry in Indiana is competitive. Each station competes with all others for customers, and sets its prices at levels which allow it to attract enough business to at least meet its costs, plus hopefully realize an acceptable margin of profit. The basic premise underlying the behavior of a single station is that total station revenues must at least equal total station costs. This relationship can be expressed as the following formula:

$$\text{Total Station Revenues} \geq \text{Total Station Costs}$$

$$\text{or} \quad (TR) \geq (TC)$$

As automotive technology changes, each station will respond to these changes by offering new types of goods and services, so long as the above formula is satisfied. Thus, a service station will be motivated to make the investments necessary for participation in a motor vehicle inspection and maintenance program only if it anticipates that the total revenues realized by performing inspections will equal or exceed these investments. The total annual station revenues associated with inspection and maintenance activities can be calculated using the following formula:

$$(TR) = N\,(P - F)$$

where N = the number of paid inspections performed by one station per year, called the "annual station throughput"

P = the price charged by the station for one inspection

F = the administrative fee paid by the station to the state for each inspection, called the "sticker fee."

The total annual station costs associated with inspection and maintenance activities can be calculated using the following formula:

$$(TC) = A + (L + \emptyset)\,N\,T + X + M + G$$

where A = the cost of an HC/CO analyzer and accessory equipment. If the original cost of the analyzer is \$3,000 and its value is depreciated to zero over 5 years, and the station borrows money to finance its purchase at an effective rate of 3 percent, the annual cost of owning the analyzer is:

$$A = \frac{\$3{,}000}{\left[\dfrac{(1.03)^5 - 1}{0.03(1.03)^5}\right]} = \$655.00$$

L = hourly labor cost for performing inspections. If the inspector earns \$5.50 per hour and his benefits cost the station one-third again as much, then the hourly cost of labor is

$$L = \$5.50 + 1/3\,(\$5.50) = \$7.33$$

N = the annual station throughput, as defined above

T = the length of time needed to perform one inspection. Based on consultations with authorities of the existing safety inspection program, this inspection time is assumed to be 15 minutes for the safety inspection plus an additional 5 minutes for the emissions test, or a total time of one-third hour.

X = the annual licensing fee paid by the station to the state, here assumed to be \$40.00

M = cost of maintaining an HC/CO analyzer, assumed to be 20 percent of the analyzer purchase price or \$600 per year

G = cost of a set of calibration gases; 50 calibrations can be performed per set; price of one set is \$200. Assume analyzer calibrated once per week

ϕ = the hourly overhead of that portion of the service station devoted to inspections. This cost can be calculated by examining the costs associated with the existing safety inspection program in Indiana. Using an average inspection time of 15 minutes, an hourly labor cost of \$7.33, and an average inspection charge of \$4.00, the above cost-revenue equation can be modified and solved for ϕ:

$$(TR) \geq (TC)$$

$$N\,(P - F) = (L + \phi)\,N\,T$$

$$\text{or}\quad (P - F) = (L + \phi)\,T$$

$$\text{so}\quad (\$4.00) = (\$7.33 + \phi)\,(1/4)$$

$$(\$16.00) = (\$7.33 + \phi)$$

$$\phi = \$8.67$$

This figure approximates the opportunity cost of that portion of the station devoted to inspection and maintenance activities; that is, the owner of the certified state inspection station will not want to engage in the business of performing inspections unless he realizes at least \$8.67 per hour in excess of the labor and equipment costs incurred in performing inspections. If less than this figure is realized, the station owner will want to put his facilities to a different use in order to capture that \$8.67.

Putting all these components back into the original cost-revenue inequality, the following relationship is derived:

$$(TR) \geq (TC)$$

$$N\,(P - F) \geq A + (L + \phi)\,N\,T + X + M + G$$

or

$$N\,(P - F) = \$655.00 + (\$7.33 + \$8.67)\,N\,(1/3) + \$40.00 + \$600.00 + \$200.00$$

In order to solve this equation for (P - F), the inspection charge, it is necessary to know the annual station throughput, N. N can be calculated by examining the total market behavior of a network of stations.

Market Behavior

Within a given geographic area, the annual throughput per station, N, can be calculated using the following formula:

$$N = \frac{I}{S}$$

where I = the total number of inspections required in the given geographic area. For purposes of analysis, I is assumed to be 1.3 times the projected registration levels, due to the fact that 30 percent of vehicles tested will fail and require reinspection.

S = the number of certified state inspection stations within the given geographic area.

Thus, the number of certified state inspection stations and the annual throughput are inversely related; as the number of such stations increases within a given geographic area, the throughput for each will decline, and vice versa. As described above, service stations are motivated to become certified state inspection stations by the potential profits to be made performing inspections. Unless they are otherwise constrained, service stations will continue to enter the inspection business so long as these profits can be realized. There is a point, however, beyond which increasing participation will mean throughputs so small that inspection revenues will not equal costs, as shown in Figure 8.

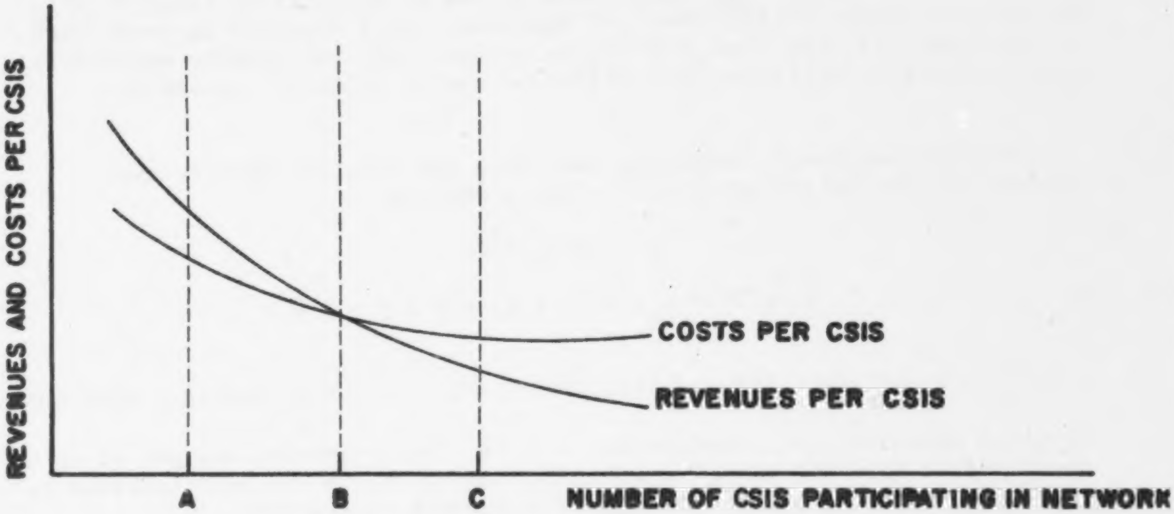


Figure 8. Market factors affecting private garage participation as certified state inspection stations.

If the participation by service stations in an inspection network is similar to the situation described by point A in the above graph, all stations will be making profits on inspections, and other nonparticipating stations will be motivated to become inspection stations. If participation is similar to the situation described by point C, however, at least some stations will be losing money on inspections, and will be motivated to drop out of the network. If participation is similar to point B, then each station in the network will just break-even on its investment in inspections. Stations will operate at this seemingly irrational point because repair business on failed vehicles is likely to be generated for stations that have the capability to perform inspections.

The market participation rate, R, is a useful characteristic for describing a network of certified state inspection stations. It is calculated using the following formula:

$$R = \frac{S}{G}$$

where S = the number of certified state inspection stations within a given geographic area

G = the total number of service stations within that area.

It is desirable from a state administrative viewpoint to keep market participation rates relatively low, or to the left of point B in the above graph. As the participation rate increases, the number of certified state inspection stations increases, and the annual throughput for each station declines. In order to at least break-even on its investment, each station must charge more per inspection. Thus, areas in which there is a comparatively low participation rate will enjoy lower inspection fees than those areas having high participation rates. On the other hand, areas having extremely low participation rates may encounter such high annual throughputs that the certified state inspection stations will not be able to keep up with demand for inspections, causing long waiting lines at inspection facilities and creating motorist dissatisfaction with the inspection program. In such cases, higher participation rates should be encouraged. Various controls which the state might exercise on the participation rate in a given area are as follows:

- Establishment of a certain fixed number of certified state inspection station licenses to be granted within a given geographic area in a given year.
- Establishment of uniform maximum or minimum fees to be charged by certified state inspection stations for performing inspections.
- Varying either the licensing fee or the state sticker fee paid by certified state inspection stations to the state.

Network Derivations

Based on discussions with officials in charge of the existing safety inspection program, it is assumed that due to the higher equipment costs associated with emissions inspections, 10 percent of the present safety inspection stations will drop out of the network. Thus, participation rates are assumed to be (0.90) times their present levels. Given these participation rates, the annual throughputs and fees charged for inspections for the various alternatives can be calculated. These calculations are presented in the discussion of each alternative.

Personnel Training

As previously mentioned, personnel training will require an ongoing program, but the initial phases of such an effort will be the most crucial. A highly intensive program must be undertaken to train and certify the staff of inspectors and investigators, managerial personnel and mechanics from the private sector who will be performing the required inspection phase of I/M if alternatives 1, 2, 5 or 6 are chosen.

It should be remembered that general acceptance of I/M is more likely if it is phased in gradually, beginning with a voluntary maintenance stage. This approach will help ease the training effort by allowing a longer period of time to fully train all the personnel.

By far the most important personnel orientation required will be that of private mechanics. They must be trained to perform repairs with I/M in mind. I/M engine parameters can be different from those engine parameters traditionally used by mechanics in tuning a vehicle for high performance. It is essential that mechanics be made aware of this shift in emphasis.

In developing cost estimates for training, it is logical to use instructors who were trained at a workshop that was held by Colorado State University (CSU) and have already been provided to Indiana. The CSU program is a pilot project that is designed specifically to meet the requirements of emissions training. CSU has specialized in the development of in-depth, comprehensive programs in emissions training for instructors as well as inspectors and mechanics involved in I/M programs. The materials they provided have been well received and recommended highly by those who are familiar with them.

There are, at this time, two instructors in Indiana who participated in a workshop that was offered by CSU in Philadelphia in 1976. These persons were chosen by the State of Indiana to participate in these courses. Using CSU-provided material, they have since passed information on to at least 20 high school level instructors as well as one instructor in almost every vocational school in the state.

Thus, it may be assumed that the emissions information and procedures have been integrated into many existing mechanics training courses. The instructors are also available to set up special emissions I/M courses (e.g., adult education courses) as well as to offer their training to other instructors.

Many of the students who participate in these training programs have voluntarily taken a "licensing" test on the relevant information. Currently, I/M mechanic licensing is not required by the state. Indiana will have to make a decision about requiring licensing in regard to an I/M program in the future. The high level of participation in the voluntary test procedure indicates that there should not be major problems in gaining acceptance of a mandatory licensing program for mechanics should the state choose to implement one.

Cost estimates were developed based on information obtained from the literature and directly from CSU. Training costs associated with a certified state inspection station scheme are likely to exceed similar costs for a contractor approach. This results primarily from the larger number of inspector/mechanics required by the former approach. Also, if certified state inspection stations prove inappropriate for use as training areas, added costs for providing a training facility may result.

The training considers three technical levels:

- additional instructors
- investigators to act as "watchdogs" for the certified state inspection stations
- inspector/mechanics

Based on a 40-hour training program for both instructors and investigators, an estimated per person training cost may be calculated. This cost is $74.00 and $59.00, respectively, when the certified state inspection station (decentralized) approach is used. (See Table 4.) With this method, a 12-hour program for inspector/mechanic training will cost roughly $22.00 per person. These figures include public relations training as well as emissions related training, as the interaction between the inspector/mechanic and the public is very important. If the certified state inspection stations themselves could be used for the training, the cost could be lessened. For the contractor approach, costs are estimated at $53.00, $43.00, and $16.00, respectively, for training instructors, investigators, and inspectors.

SECTION 3

ALTERNATIVE 1 - • COMBINED EMISSIONS AND SAFETY INSPECTIONS PERFORMED STATEWIDE BY THE CERTIFIED STATE INSPECTION STATION NETWORK

ALTERNATIVE DEFINITION

In this alternative it is proposed that emissions testing be combined with existing motor vehicle safety inspections performed statewide by certified state inspection stations (CSIS). These stations comprise a CSIS network. Each station is a privately-owned establishment (garage and/or service station) that has been certified by the State of Indiana to perform inspections. It is estimated that the emissions testing element will take 5 minutes to perform, extending the existing safety inspection performance time to 20 minutes.

DETERMINATION OF THE CERTIFIED STATE INSPECTION STATION NETWORK

The key elements used in calculating the cost of emissions testing are the number of motor vehicles affected by the program and the number of private establishments or CSIS participating in the program. Based on motor vehicle population projections and the behavior of certified state inspection stations (CSIS) analyzed in Section 2, accurate cost figures can be developed.

Relevant Vehicle Population

The first step in establishing an I/M program cost estimate involves determination of the number of inspections to be conducted in 1987. This has been calculated in Section 2. The projected vehicle population for 1987 is 4,877,000. For purposes of analysis, however, this figure must be adjusted. First, because various exemptions will be granted to certain segments of the vehicle population (exempting vehicles over 13 years old), only 96 percent of the original figure will be covered by a statewide I/M program. Second, the vehicle population figure must be increased by a factor of 1.3 to account for the 30 percent of the population failing inspection and requiring reinspection. This last adjustment is necessary because the program, in order to realize acceptable emissions levels, will be designed intentionally to fail 30 percent of the vehicle population. For study purposes, it is assumed that no vehicle fails reinspection. Thus, for Alternative 1, in 1987, the CSIS network will be required to perform 6,086,496 inspections.

DISTRIBUTION OF CERTIFIED STATE INSPECTION STATION NETWORK

For this analysis, the State of Indiana has been divided into six administrative regions, illustrated in Figure 9. The number of certified

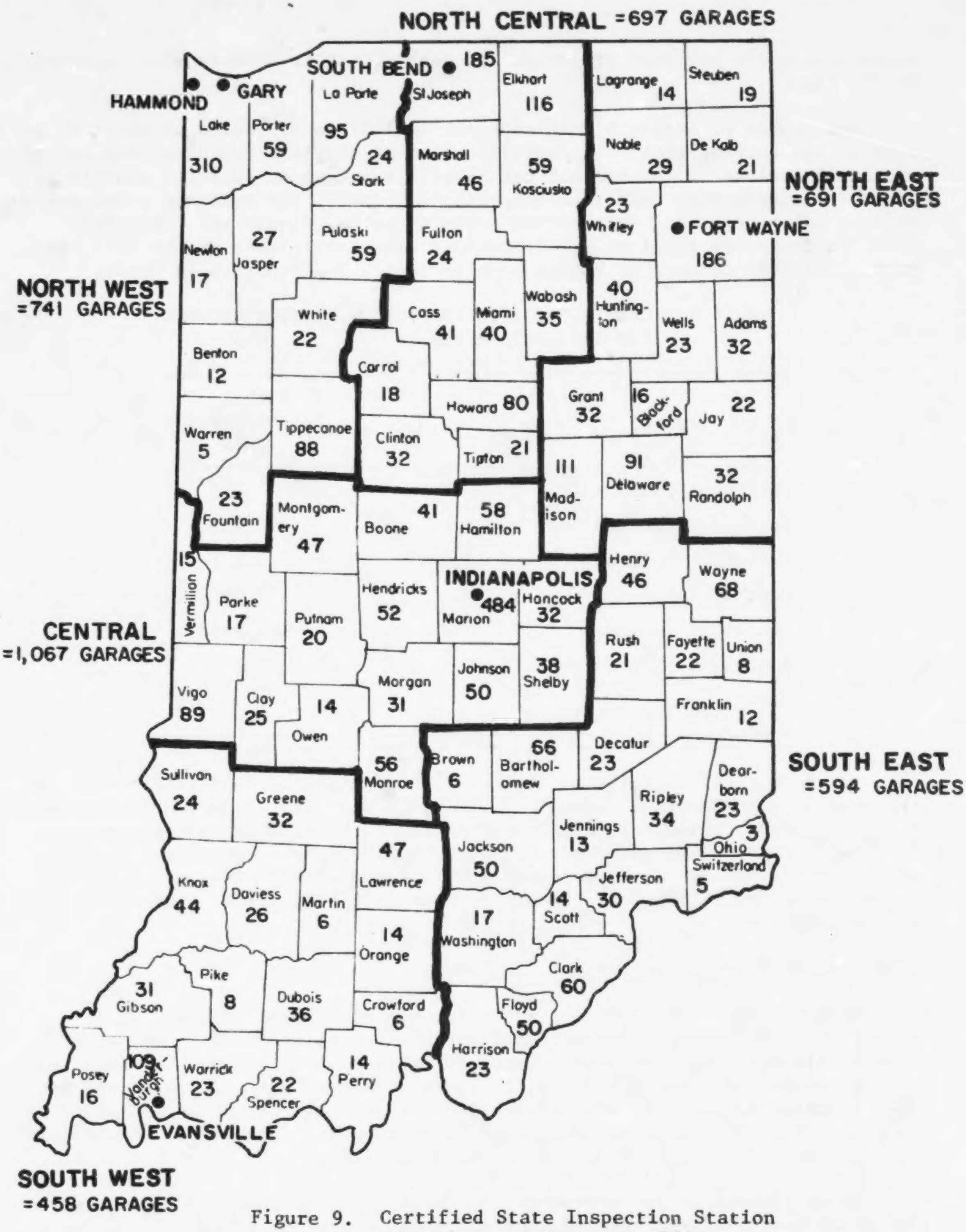

NORTH CENTRAL =697 GARAGES
NORTH EAST =691 GARAGES
NORTH WEST =741 GARAGES
CENTRAL =1,067 GARAGES
SOUTH EAST =594 GARAGES
SOUTH WEST =458 GARAGES
HAMMOND
GARY
SOUTH BEND
185
FORT WAYNE
INDIANAPOLIS
EVANSVILLE
Lake 310
Porter 59
La Porte 95
St Joseph
Elkhart 116
Lagrange 14
Steuben 19
Stark 24
Marshall 46
Kosciusko 59
Noble 29
De Kalb 21
Newton 17
Jasper 27
Pulaski 59
Fulton 24
Whitley 23
186
White 22
Cass 41
Miami 40
Wabash 35
Huntington 40
Wells 23
Adams 32
Benton 12
Carrol 18
Howard 80
Grant 32
Blackford 16
Jay 22
Warren 5
Tippecanoe 88
Clinton 32
Tipton 21
Madison 111
Delaware 91
Randolph 32
Fountain 23
Montgomery 47
Boone 41
Hamilton 58
Vermillion 15
Parke 17
Putnam 20
Hendricks 52
Marion 484
Hancock 32
Henry 46
Wayne 68
Rush 21
Fayette 22
Union 8
Vigo 89
Clay 25
Owen 14
Morgan 31
Johnson 50
Shelby 38
Franklin 12
Sullivan 24
Greene 32
Monroe 56
Brown 6
Bartholomew 66
Decatur 23
Ripley 34
Dearborn 23
Ohio 3
Jennings 13
Jackson 50
Lawrence 47
Switzerland 5
Jefferson 30
Knox 44
Daviess 26
Martin 6
Orange 14
Scott 14
Washington 17
Clark 60
Gibson 31
Pike 8
Dubois 36
Crawford 6
Floyd 50
Harrison 23
Posey 16
Vanderburgh 109
Warrick 23
Spencer 22
Perry 14

Figure 9. Certified State Inspection Station Network for Indiana in 1987.

state inspection stations projected for each county in 1987 is also included in the figure.

The number of stations participating in 1987 is projected at about 90 percent of the current total. A certain number of stations (here assumed not to exceed 10 percent of the present total) will not want to bear the additional costs associated with emissions inspections; namely, the purchase price and ongoing maintenance and calibration costs of an HC/CO analyzer. For 1987, then, an estimated total of 4,248 stations will participate in the CSIS network. The 1987 network is broken down by region and reported in Table 5.

TABLE 5. CERTIFIED STATE INSPECTION STATION NETWORK FOR 1987 ALTERNATIVE 1

Region	Number of participating CSIS
Northwest Indiana	741
North Central Indiana	697
Northeast Indiana	691
Central Indiana	1,067
Southeast Indiana	594
Southwest Indiana	458
Statewide Total	4,248

Based on total anticipated statewide inspections in 1987 (6,086,496) and the size of the 1987 CSIS network (4,248 stations), each CSIS will be required to perform approximately 1440 inspections yearly. Assuming that inspections will be performed 250 days per year, each CSIS must perform 5.7 inspections daily. It is assumed that performance of a combined emissions and safety inspection takes 20 minutes; therefore, each CSIS must devote 2 hours per day to inspections.

Requirements for Quality Control

In order to assure continuing public support for the program, it is important to guarantee maintenance of effective quality control over the entire CSIS network. The CSIS network for this alternative may be viewed as a large number of HC/CO analyzers that must be accurately calibrated and frequently checked; the U.S. EPA has specified that calibrations be performed monthly. For this purpose, the agency overseeing the I/M program should maintain a fleet of inspection and licensing vans (ILV).

These vehicles will be equipped to check the accuracy of HC/CO analyzers in use at certified state inspection stations. Based on monthly inspections, it is assumed that one inspection and licensing van is needed to properly oversee 70 certified state inspection stations. ILV requirements calculated include an additional 15 percent reserve figure over and above the basic to account for breakdowns, scheduled maintenance, etc.

Complaint investigation vehicles are also needed. Approximately one such vehicle per 100 CSIS locations should be sufficient; a 15 percent breakdown reserve or cushion is again assumed. The inspection and licensing van and complaint investigator vehicle requirements are broken down by region and presented in Table 6.

TABLE 6. INSPECTION AND LICENSING VANS AND COMPLAINTS VEHICLES NEEDED TO ASSURE QUALITY CONTROL OVER THE CSIS NETWORK FOR ALTERNATIVE 1

Region	Number of CSIS	Number of I&L vans	Number of complaints vehicles
Northwest Indiana	741	13	9
North Central Indiana	697	12	8
Northeast Indiana	691	12	8
Central Indiana	1,067	18	13
Southeast Indiana	594	10	7
Southwest Indiana	458	8	6
Total	4,248	73	51

FEE CALCULATIONS FOR THE CERTIFIED STATE INSPECTION STATION NETWORK

CSIS Inspection Fee Computation

Fee calculations have been made based on both free and paid reinspections. As derived in Section 2, the following formula determines the fee a CSIS will charge:

$$N (P - F) = A + (L + \emptyset) N T + X + M + G$$

where N = paid inspections performed at one CSIS in 1 year

P = price charged by a CSIS for an inspection

F = administrative fee paid to the state by a CSIS for each safety inspection

A = Annualized cost of owning an HC/CO analyzer, assumed to be $655

L = hourly labor cost, assumed to be $7.33, including labor overhead

$\emptyset$ = overhead cost for the bay used to perform the CSIS inspection, assumed to be \$8.67 per hour.

T = Length of time needed to perform an inspection. An emissions only test is assumed to take 5 minutes, a safety inspection is 15 minutes long and a combined test lasts 20 minutes.

M = maintenance cost for an HC/CO analyzer, assumed to be 20 percent of purchase price or \$600 per year.

G = cost of calibration gas for HC/CO analyzer, assumed to be \$200 per year.

The critical values in this formula are throughput, (N), and the amount of time spent in testing, (T). The cost to the CSIS of performing a combined safety and emissions test with paid retests is calculated below:

$$\text{Annual Average Throughput} = \frac{6{,}086{,}496}{4{,}248} = 1{,}433 = N$$

$$1{,}433\ (P-F) = \$655.00 + (\$16.00)(1{,}433)(\tfrac{1}{3}) + \$40.00 + \$600.00 + \$200.00$$

$$(P-F) = \$9{,}137.66/1{,}433$$

$$= \$6.377$$

Thus, assuming paid retests of failed vehicles, a combined safety and emission test costs \$6.377 per inspection. If free reinspections are assumed, the cost per inspection will be higher, as the original test fee must also cover the costs of performing reinspections. Assuming free reinspections, the combined test cost rises to \$7.590.

It is useful for purposes of comparison to separate out that portion of the combined test cost generated by emissions testing. This figure can be derived using the same cost formula as above, but substituting a 5 minute, rather than a 20 minute, throughput.

$$(1{,}433)(P-F) = \$655.00 + (\$16.00)(1{,}433)(\tfrac{1}{12}) + \$40.00 + \$600.00 + \$200.00$$

$$(P-F) = \$3{,}405.66/1{,}433$$

$$= \$2.377$$

If free retests are desired, this emissions test cost rises to \$3.09. Alternative 1 CSIS inspection costs are summarized in Table 7.

TABLE 7. CSIS INSPECTION COSTS, ALTERNATIVE 1, 1987
(CONSTANT 1978 DOLLARS)

Inspection type	Paid retests ($)	Free retests ($)
Safety	4.00 + 0.50*	
Emissions	2.38	3.09
Combined Safety & Emissions	6.88	7.59

*Under the existing safety inspection program, the original test costs $4.00 plus a $0.50 state sticker fee, and retests are free. It is assumed that this would continue under a combined inspection program.

Note: GCA calculations, 1978.

State Emissions Sticker Fee Computation

It should be emphasized that the costs calculated above do not represent the entire fee which each motorist will pay. In addition to the cost of performing inspections, the fee collected must also include an administrative, or "sticker" fee levied by the state to cover program administrative costs. This fee is calculated in Table 8. State-level administrative salaries and other expenditures have been kept to a minimum in this calculation. It is assumed at this level of analysis that involvement of the APCD will be minimal and that the state-level administrative system supervising the present safety inspection program has sufficient manpower to handle a combined safety and emissions inspection program. Those administrative salaries, thus, included in cost calculations for this alternative as identified in Figure 6, do not represent the final analysis of an administrative network. They are, however, sufficient at this stage to provide comparative figures, as required.

Table 9 shows the total inspection charge (P), to be paid by a motorist under alternative 1 for both paid and free reinspections.

PUBLIC INFORMATION PROGRAM COSTS

The cost estimate for a public relations program for alternative 1 is based on current state and contractor experience in operating I/M programs. A cost figure of $0.12 per vehicle inspected is assumed. This figure may change with program design. For alternative 1, using a vehicle population of 4,877,000, a $585,240 cost figure results. In future years of I/M program implementation, this cost may be lowered if the public relations effort for emissions inspections can be combined with that campaign already in place for the safety inspection program.

TABLE 8. STATE EMISSIONS STICKER FEE CALCULATIONS, ALTERNATIVE 1, 1987 (CONSTANT 1978 DOLLARS)

	when i = 0.06	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital costs			
	1. 73 inspection and licensing vehicles	642,400	0.2374	152,506
	2. 51 complaints vehicles	255,000	0.2374	60,537
II.	One-time startup costs			
	1. Personnel training	5,418	0.2374	1,286
	2. Personnel salaries and overhead	3,269,063	0.2374	776,076
III.	Annual operating costs			
	1. Maintenance	179,480	1.0	179,480
	2. Calibration	642,400	1.0	642,400
	3. Personnel salaries and overhead	2,179,375	1.0	2,179,375
IV.	Annual administrative costs	107,375	1.0	107,375
	Total			4,099,035
	State sticker fee$_{0.06}$	$= \frac{\$4,099,035}{6,086,496}$	= $0.67	

Note: GCA calculations, 1978.

TABLE 8(a). STATE EMISSIONS STICKER FEE CALCULATIONS, ALTERNATIVE 1, 1987 (CONSTANT 1978 DOLLARS)

	when i = 0.03	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital costs			
	1. 73 inspection and licensing vehicles	642,400	0.2184	140,301
	2. 51 complaints vehicles	255,000	0.2184	55,692
II.	One-time startup costs			
	1. Personnel training	5,418	0.2184	1,183
	2. Personnel salaries and overhead	3.269,063	0.2184	713,963
III.	Annual operating costs			
	1. Maintenance	179,480	1.0	179,480
	2. Calibration	642,400	1.0	642,400
	3. Personnel salaries and overhead	2,179,375	1.0	2,179,375
IV.	Annual administrative costs	107,375	1.0	107,375
	Total			4,019,769
	State sticker fee$_{0.03}$	$= \frac{\$4{,}019{,}769}{6{,}086{,}496}$	= $0.66	

TABLE 9. TOTAL INSPECTION CHARGE, (P) FOR ALTERNATIVE 1, 1987 (CONSTANT 1978 DOLLARS) i = 0.06

Inspection charge component	Paid retests ($)	Free retests ($)
Safety inspection fee	4.00 + 0.50*	
Emissions inspection fee	2.38	3.09
Emissions sticker fee	0.67	0.87
Total inspection charge	7.55	8.46

*Under the present system, safety reinspections are free. Costs are $4.00 for the CSIS plus $0.50 for the safety sticker fee.

Note: GCA calculations, 1978.

POSSIBLE EXTERNALITIES AND LEGISLATIVE CONSIDERATIONS

General issues concerning possible externalities and legislative considerations for I/M programs are discussed in Sections 9 and 10, respectively; they are briefly reviewed here in the context of alternative 1. There are no specific legal roadblocks, either federal or state, that stand in the way of implementing alternative 1; rather, implementation problems are more likely to be practical or political in nature.

It is estimated that each certified state inspection station will have to devote about 2 hours per day to combined emission and safety inspection duties. This amounts to 1/2 hour more time spent than would normally be devoted to performing only safety inspections. It is unlikely that this extra time spent on emissions testing would be seen as an excessive burden.

The geographic coverage for this alternative is clearly defined; there are no practical difficulties in using state lines as program boundaries. By treating the entire state population in the same manner, this alternative helps eliminate the possible argument that some must bear a burden for the benefit of all. There will remain the possibility that citizens living in relatively unpolluted rural areas may feel that they should not be forced to participate in an I/M scheme. However, well-designed public information effort can help eliminate such adverse public reaction. More importantly, public relations will help allay public distrust of the automotive repair industry in general. Only by properly promoting the quality assurance effort that is associated with the CSIS network alternative can this distrust be alleviated. Thus, program implementation details will have to be carefully worked out.

EMISSION REDUCTION BENEFITS

Inspection/maintenance is designed to reduce automobile emissions in order to improve ambient air quality by lowering pollution levels. The magnitude of potential emissions reductions is dependent on the size of the vehicle population covered by a mandatory program. 1987 tailpipe emission reductions that would result from implementing I/M were calculated using the Environmental Protection Agency's Mobile I computer routine.

The results of these calculations are reported in Tables 10 and 11. Statewide vehicle HC emissions with I/M will be 234,855 kg per day. This represents a 26.3 percent reduction over emission levels that would occur in 1987 in the absence of I/M. Carbon monoxide vehicle emissions will be 2,232,249 kg per day statewide in 1987 with I/M. This is a 32.1 percent reduction over 1987 non-I/M levels.

TABLE 10. DAILY HYDROCARBON EMISSIONS FOR ALTERNATIVE 1 (kg/day)

Area	Heavy-Duty Trucks									Light-Duty Vehicles												All Vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M Auto	1987 With I/M Auto	1975 LD-Truck	1982 LD-Truck	1987 Without I/M LD-Truck	1987 With I/M LD-Truck	1975 Total	1982 Total	1987 Without I/M Total	1987 With I/M Total	1975	1982	1987 Without I/M	1987 With I/M	Percent Reduction 1977 to 1987 With I/M	Percent Reduction 1987 Without I/M to 1987 With I/M
Allen County	290	260	220	1,460	1,130	516	1,747	1,380	766	22,780	11,666	6,790	6,062	3,606	2,434	1,313	1,033	26,264	14,120	8,312	5,675	28,011	15,500	9,035	6,419	77.1%	29.1%
Clark County	189	736	534	385	375	143	974	1,013	696	9,606	4,893	2,806	2,083	2,700	1,897	1,217	980	12,306	6,770	4,023	2,871	13,360	7,005	4,711	3,367	73.3%	28.4%
Floyd County	231	180	237	151	180	37	402	416	304	3,750	2,132	1,330	919	1,111	812	563	300	4,870	2,944	1,893	1,300	5,272	3,362	2,297	1,622	69.1%	29.3%
Lake and Porter Counties	2,786	3,070	2,606	18,120	13,419	7,380	20,886	16,489	9,773	37,330	16,025	8,367	5,396	12,073	6,366	3,783	3,777	50,406	22,409	14,250	9,173	60,790	38,898	24,133	19,163	68.2%	28.6%
Marion County	1,490	1,786	1,371	13,119	11,593	7,386	16,609	13,299	8,765	56,296	29,617	13,386	13,176	10,000	7,003	4,790	3,128	66,353	44,642	38,106	18,404	100,982	59,941	38,948	27,120	73.4%	26.5%
St. Joseph County	366	303	221	1,335	1,136	304	2,001	1,479	725	23,317	11,169	6,126	6,114	4,299	2,662	1,600	1,066	27,620	13,831	7,732	5,196	29,817	15,266	8,467	5,939	80.1%	29.9%
Remainder of State	4,450	4,894	5,136	46,837	46,360	27,388	51,293	50,614	32,666	430,312	248,486	138,130	107,775	89,127	63,396	44,356	28,363	512,639	311,082	280,136	138,348	563,932	362,616	233,190	171,066	69.7%	22.3%
Statewide	10,000	12,400	10,190	83,820	72,830	43,500	93,900	86,630	53,080	595,080	331,900	205,230	140,325	113,850	85,028	59,700	40,046	789,730	418,760	263,030	181,163	883,670	503,370	318,730	236,855	70.7%	26.3%

TABLE 11. DAILY CARBON MONOXIDE EMISSIONS FOR ALTERNATIVE 1 (kg/day)

Area	Heavy-Duty Trucks									Light-Duty Vehicles												All Vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M Auto	1987 With I/M Auto	1975 LD-Truck	1982 LD-Truck	1987 Without I/M LD-Truck	1987 With I/M LD-Truck	1975 Total	1982 Total	1987 Without I/M Total	1987 With I/M Total	1975	1982	1987 Without I/M	1987 With I/M	Percent Reduction 1977 to 1987 With I/M	Percent Reduction 1987 Without I/M to 1987 With I/M
Allen County	1,783	1,628	1,702	15,661	18,701	11,765	17,444	20,329	13,467	164,166	102,517	59,307	32,443	24,180	21,742	15,715	8,507	188,367	124,259	75,022	41,062	205,691	144,588	88,469	54,389	73.5%	38.4%
Clark County	4,213	4,086	4,181	4,342	4,440	3,254	8,555	8,516	7,435	72,770	45,380	26,085	15,497	18,965	17,433	12,940	7,683	91,715	62,821	39,036	23,190	100,270	71,335	46,460	30,625	69.5%	34.1%
Floyd County	1,985	1,722	1,958	1,666	1,780	1,150	3,651	3,482	3,117	29,616	20,177	12,676	7,154	7,752	7,755	6,070	3,485	37,368	27,932	18,546	10,639	40,019	31,384	21,671	13,756	66.5%	36.5%
Lake and Porter Counties	21,007	19,399	19,830	202,234	194,060	108,996	223,951	213,339	128,816	256,451	167,080	83,712	46,327	109,025	99,113	65,271	38,112	368,476	266,986	148,983	82,439	592,067	480,323	277,799	211,255	66.3%	24.0%
Marion County	11,609	10,491	11,157	141,155	143,827	100,098	152,764	154,318	111,255	665,383	385,536	213,619	115,275	70,914	69,440	36,867	19,884	724,407	454,976	250,466	135,150	877,201	609,294	361,721	246,410	71.9%	31.9%
St. Joseph County	2,026	1,722	1,703	18,460	19,461	11,637	20,482	21,183	13,360	179,815	102,144	51,313	29,645	31,099	25,340	15,910	9,192	210,716	127,732	67,223	38,837	231,200	148,915	80,563	52,177	77.4%	35.2%
Remainder of State	28,630	29,662	26,740	514,416	756,653	660,301	543,053	785,315	705,070	2,890,539	2,007,538	1,343,890	732,406	426,735	470,811	433,750	236,037	3,317,274	2,368,350	1,779,040	968,443	3,860,327	3,154,665	2,484,710	1,673,513	56.7%	32.6%
Statewide	71,750	68,500	77,280	897,940	1,130,000	905,210	980,690	1,307,440	982,380	4,241,940	2,901,150	1,702,620	938,750	694,370	711,090	585,520	321,080	4,938,310	3,613,040	2,370,930	1,299,767	5,908,000	4,920,480	3,301,430	2,282,260	61.6%	32.1%

Reproduced from
best available copy.

SECTION 4

ALTERNATIVE 2 -

- CERTIFIED STATE INSPECTION STATIONS PERFORMING COMBINED IDLE-MODE EMISSION AND SAFETY INSPECTIONS IN SEVEN NONATTAINMENT COUNTIES
- CERTIFIED STATE INSPECTION STATIONS PERFORMING ONLY THE EXISTING SAFETY INSPECTION IN THE REMAINDER OF THE STATE

ALTERNATIVE DEFINITION

In alternative 2 it is proposed that an I/M program be implemented in the seven Indiana counties which have populations greater than 200,000 and have not attained national ambient air quality standards for CO and O_x pollutants (Allen, Clark, Floyd, Lake, Marion, Porter and St. Joseph Counties). Within these counties, alternative 2 would add emissions testing to the safety inspection functions carried out by the existing certified state inspection station (CSIS) network. The remainder of the state would not be required to participate in an I/M program under this scheme; however, the existing safety inspection program carried out by certified state inspection stations would continue.

DETERMINATION OF CERTIFIED STATE INSPECTION STATION NETWORK

The certified state inspection station network of concern to alternative 2 is located within the seven nonattainment counties. The key information needed to determine the cost of performing tests in this network consists of two factors: first, the size of the vehicle population in these counties; and second, the number of private facilities in the counties serving as certified state inspection stations.

Relevant Vehicle Population

That portion of the vehicle population that lies within the seven nonattainment counties has been projected for 1987 using the method described in Section 2. This figure is multiplied by 0.96 to remove those portions of the vehicle population exempted from I/M coverage. This adjusted vehicle population figure is then increased 30 percent (30 percent stringency rate assumed) to yield the total number of inspections required. Registrations and required inspections for the seven nonattainment counties in 1987 appear in Table 12.

TABLE 12. VEHICLE REGISTRATIONS AND REQUIRED INSPECTIONS FOR NONATTAINMENT COUNTIES IN 1987

County	Vehicle registrations	Required inspections
Allen	297,566	371,362
Clark	88,564	110,528
Floyd	53,924	67,297
Lake	476,381	594,524
Marion	711,211	887,591
Porter	116,109	144,904
St. Joseph	205,096	255,960
Total	1,948,851	2,432,166

DISTRIBUTION OF CERTIFIED STATE INSPECTION STATIONS

It is assumed that the CSIS network within the seven nonattainment counties will decline to 90 percent of its present size by 1987. This 10 percent decline is attributed to withdrawal from the inspection network by stations unwilling to make the capital investments associated with emissions inspections; namely, the purchase price and ongoing calibration costs of an HC/CO analyzer. The number of certified state inspection stations in each of the seven counties is reported in Table 13.

TABLE 13. 1987 CSIS NETWORK IN SEVEN NONATTAINMENT COUNTIES

County	Number of participating CSIS
Allen	186
Clark	60
Floyd	50
Lake	310
Marion	484
Porter	59
St. Joseph	185
Total	1,334

Source: GCA calculations, 1978.

Based on the number of inspections that must be performed in the seven nonattainment counties in 1987 (2,432,166) and the size of the CSIS network within those counties (1,334 stations), each CSIS will perform an average of 1,825 inspections each year. At 20 minutes per combined emission and safety inspection, each station will spend approximately 2-1/2 hours inspecting 7.3 cars per day during a 250-day work year.

Requirements for Quality Control

In order to assure continuing public support for the program, maintaining a high level of quality control is especially important for alternative 2. A CSIS network implies a large number of complex HC/CO analyzers that must be accurately calibrated and maintained. For this purpose, the agency administering the I/M program should maintain a fleet of inspection and licensing vans (ILV) having capabilities of testing station analyzers and providing calibration standards. The U.S. EPA has specified that calibrations be performed monthly; it is assumed that one ILV is capable of overseeing 70 CSIS facilities.

In addition, a number of complaints investigators should be assigned to follow up on consumer complaints and reports of problems. One complaints vehicle is assumed to be capable of making 100 certified state inspection station visits per month.

Allowing an additional 15 percent over the above figures as a cushion or reserve for breakdowns, maintenance, etc., the number of quality control vehicles or ILV required for alternative 2 is shown in Table 14.

TABLE 14. INSPECTION AND LICENSING VANS AND COMPLAINTS VEHICLES NEEDED TO ASSURE QUALITY CONTROL OVER THE CSIS NETWORK FOR ALTERNATIVE 2

County	Number of inspection and licensing vans	Number of complaints vehicles
Allen	3	2
Clark	2	2
Floyd	2	2
Lake	5	4
Marion	8	6
Porter	2	2
St. Joseph	3	3
Total	25	21

Note: GCA calculations, 1978.

FEE CALCULATIONS FOR THE CERTIFIED STATE INSPECTION STATION NETWORK

CSIS Inspection Fee Computation

Fee calculations have been made based on both free and paid reinspections. As derived in Section 2, the following formula determines the fee a CSIS will charge.

$$N\ (P - F) = A + (L + \emptyset)\ N\ T + X + M + G$$

where N = paid inspections performed at one CSIS in 1 year

P = price charged by a CSIS for an inspection

F = administrative fee paid to the state by a CSIS for each inspection

A = annualized cost of owning an HC/CO analyzer, assumed to be $655

L = hourly labor cost, assumed to be $7.33 including labor overhead

Ø = overhead cost for the bay used to perform the CSIS inspection, assumed to be $8.67 per hour

T = Length of time needed to perform an inspection. An emissions only test is assumed to take 5 minutes, a safety inspection is 15 minutes long, and a combined test lasts 20 minutes.

X = the annual licensing fee paid by the station to the state, here assumed to be $40.00

M = Maintenance cost for an HC/CO analyzer, assumed to be 20 percent of its purchase price or $600 per year.

G = cost of calibration gas for HC/CO analyzer, assumed to be $200 per year

The critical values in this formula are throughput (N) and the amount of time spent in testing (T). The cost to the CSIS of performing a combined safety and emissions test with paid retests is calculated below:

$$\text{Average annual throughput} = \frac{2{,}432{,}166}{1{,}334} = 1{,}832.21$$

$$1{,}832.21\ (P - F) = \$655 + (\$16.00)(1{,}832.21)(1/3) + \$40.00 + \$600.00 + \$200.00$$

$$(P - F) = \frac{\$11{,}266.785}{1{,}832.21}$$

$$= \$6.149$$

Thus, assuming paid retests of failed vehicles, a combined safety and emissions test costs \$6.149 per inspection. If free reinspections are assumed, the cost per inspection will be higher, as the original test fee must also cover the costs of performing reinspections. Assuming free reinspections, the combined test cost rises to \$7.994.

It is useful for purposes of comparison to separate out that portion of a combined test cost generated by emissions testing. This figure can be derived using the same cost formula as outlined on page 58, but substituting a 5-minute, rather than a 20-minute, throughput.

$$(1{,}832.21)\ (P - F) = \$655.00 + (\$16.00)(1{,}832.21)(1/12) + \$40.00 + \$600.00 + \$200.00$$

$$(P - F) = \frac{\$3{,}937.95}{1{,}832.21}$$

$$= \$2.149$$

If free retests are desired, this emissions test cost rises to \$2.794. Alternative 2 CSIS inspection costs are summarized in Table 15.

TABLE 15. CSIS INSPECTION COSTS, ALTERNATIVE 2, 1987 (CONSTANT 1978 DOLLARS)

Inspection type	Paid retests	Free retests
Safety	4.00 + 0.50*	
Emissions	2.15	2.80
Combined safety and emissions	6.65	7.29

*Under the existing safety inspection program, inspections cost \$4.00 plus a \$0.50 sticker fee. It is assumed that this would continue under a combined inspection program.

State Emissions Sticker Fee Computation

It should be emphasized that the costs presented in Table 15 do not represent the entire fee which the motorist will pay. In addition to the cost of performing inspections, the fee collected must also include an administrative, or "sticker" fee levied by the state to cover program costs. This fee is calculated in Table 16. Minimum administrative salaries and other expenditures at the state level have been included in this calculation as it is assumed here, for comparative purposes, that the present safety inspection program has sufficient manpower to handle a combined safety and emissions inspection program and that involvement of the APCD will be minimal. This assumption allows for the calculation of comparative figures, as required at this level, and leaves more detailed analysis and policy determination for the next phase.

TABLE 16. STATE EMISSIONS STICKER FEE CALCULATIONS, ALTERNATIVE 2, 1987 (CONSTANT 1978 DOLLARS)

When i = 0.06	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital costs			
1. 25 inspection and licensing vehicles	220,000	0.2374	52,228
2. 21 complaints vehicles	105,000	0.2374	24,927
II. One-time startup costs			
1. Personnel training	1,978	0.2374	470
2. Personnel salaries and overhead	1,199,063	0.2374	284,658
III. Annual operating costs			
1. Maintenance	65,000	1.0	65,000
2. Calibration	220,000	1.0	220,000
3. Personnel salaries and overhead	799,375	1.0	799,375
IV. Annual administrative costs	107,375	1.0	107,375
Total			1,554,033
State sticker fee$_{0.06}$	$= \frac{\$1{,}554{,}033}{2{,}432{,}166}$	$= \$0.64$	

Note: GCA calculations, 1978.

TABLE 16(a). STATE EMISSIONS STICKER FEE CALCULATIONS, ALTERNATIVE 2, 1987 (CONSTANT 1978 DOLLARS)

	When i = 0.03	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital costs			
	1. 25 inspection and licensing vehicles	220,000	0.2184	48,048
	2. 21 complaints vehicles	105,000	0.2184	22,932
II.	One-time startup costs			
	1. Personnel training	1,978	0.2184	432
	2. Personnel salaries and overhead	1,199,063	0.2184	261,875
III.	Annual operating costs			
	1. Maintenance	65,000	1.0	65,000
	2. Calibration	220,000	1.0	220,000
	3. Personnel salaries and overhead	799,375	1.0	799,375
IV.	Annual administrative costs	107,375	1.0	107,375
	Total			1,525,037
	State sticker fee$_{0.03}$ =	$\frac{\$1,525,037}{2,432,166}$	= \$0.63	

Table 17 shows the total inspection charge (P), to be paid by a motorist under alternative 2 for both paid and free reinspections.

TABLE 17. TOTAL INSPECTION CHARGE, (P) FOR ALTERNATIVE 2, 1987 (CONSTANT 1978 DOLLARS) i = 0.06

Inspection charge component	Paid retests ($)	Free retests ($)
Safety inspection fee	4.00 + 0.50*	
Emissions inspection fee	2.15	2.80
Emissions sticker fee	0.64	0.83
Total inspection charge	7.29	8.13

*Under the present system, safety reinspections are free. Costs are $4.00 for the CSIS plus $0.50 for the safety sticker fee.

Note: GCA calculations, 1978.

PUBLIC INFORMATION PROGRAM COSTS

The cost estimate for a public relations program for alternative 2 is based on the experience of various states and contractors currently operating I/M programs. A $0.12 cost per vehicle inspected is assumed here; however, this figure may change readily with the extent of the program designed. For this alternative, using a vehicle population of approximately 1,948,800, a $233,856 cost would result. In future years of I/M program implementation, it is possible that this cost could be lowered by combining the I/M public relations effort with that already existing for the safety inspection program.

POSSIBLE EXTERNALITIES AND LEGISLATIVE CONSIDERATIONS

General issues concerning possible externalities and legislative considerations for I/M programs are discussed in Sections 9 and 10, respectively; they are briefly reviewed here in the context of alternative 2. There are no specific legal roadblocks at either the federal or state level that stand in the way of implementing alternative 2; rather, implementation problems are more likely to be practical or political in nature.

Each private facility participating in the CSIS network for alternative 2 will have to devote approximately 3 hours per day to performing combined emissions and safety inspections. This is twice the average length of time which stations in the present network are currently devoting to performing only safety inspections. If the present network is operating at or near total capacity, the additional time requirements of alternative 2 may overburden the network, causing long waiting lines at inspection stations and jeopardizing public acceptance of the program. It is, therefore, possible that more stations will have to be added to the 1987 alternative 2 CSIS network to provide additional inspection capacity.

The geographic coverage for this alternative is clearly defined; there are not likely to be practical difficulties in using established county lines with which the public is already familiar, as program boundaries. There may be complaints from citizens within the seven counties that they are being forced arbitrarily to bear the additional expense of an emissions inspection. A well-designed public information program (see Appendix C) can minimize this adverse public reaction by pointing out that the seven counties were not designated arbitrarily, but rather on the basis of their nonattainment status and their large motor vehicle populations.

Public information programs can also be used to counter a much more serious obstacle to public acceptance of alternative 2; namely, the general distrust of the automotive repair industry on the part of the motoring public. Only with proper promotion of the quality assurance effort associated with alternative 2 program administration can this distrust be alleviated. Thus, program implementation details for alternative 2 will require careful scrutiny.

EMISSION REDUCTION BENEFITS

Inspection/maintenance is designed to improve ambient air quality by lowering vehicular emission levels. The magnitude of potential emissions reductions is dependent on the size of the vehicle population covered by a mandatory program. 1987 tailpipe emission reductions that would result from implementing I/M were calculated using the Environmental Protection Agency's Mobile I computer routine.

The results of these calculations appear in Tables 18 and 19. Statewide vehicle HC reductions will be 6.8 percent of 1987 non-I/M levels if the program is implemented. This figure is somewhat misleading, though. The vast majority of emission reduction benefits will occur within the seven counties in which the program operates. Reductions in emissions over 1987 non-I/M levels vary from 20.2 to 28.8 percent per county. Total vehicle HC emissions in 1987 with I/M, will be 297,008 kg daily.

CO emissions in 1987 with I/M, will be 3,092,662 kg per day. This represents an 8.0 percent reduction statewide over non-I/M 1987 levels. Reductions for the seven counties vary between 23.4 and 35.6 percent per county.

TABLE 18. DAILY HYDROCARBON EMISSIONS FOR ALTERNATIVE 2 (kg/day)

Area	Heavy-duty trucks									Light-duty vehicles												All vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M auto	1987 With I/M auto	1975 LD-truck	1982 LD-truck	1987 Without I/M LD-truck	1987 With I/M LD-truck	1975 Total	1982 Total	1987 Without I/M total	1987 With I/M total	1975	1982	1987 Without I/M	1987 With I/M	Percent reduction 1975 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Allen County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Floyd County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lake and Porter Counties	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Marion County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St. Joseph County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Remainder of State	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Statewide	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 19. DAILY CARBON MONOXIDE EMISSIONS FOR ALTERNATIVE 2 (kg/day)

Area	Heavy-duty trucks									Light-duty vehicles												All vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M auto	1987 With I/M auto	1975 LD-truck	1982 LD-truck	1987 Without I/M LD-truck	1987 With I/M LD-truck	1975 Total	1982 Total	1987 Without I/M total	1987 With I/M total	1975	1982	1987 Without I/M	1987 With I/M	Percent reduction 1975 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Allen County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Floyd County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lake and Porter Counties	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Marion County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St. Joseph County	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Remainder of State	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Statewide	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Reproduced from best available copy.

SECTION 5

ALTERNATIVE 3 -
- STATEWIDE SAFETY INSPECTION BY CERTIFIED STATE INSPECTION STATIONS
- CONTRACTOR OPERATED IDLE-MODE EMISSIONS INSPECTIONS IN SEVEN NONATTAINMENT COUNTIES

ALTERNATIVE DEFINITION

In this alternative, idle mode emissions testing will be conducted in centralized facilities to be established and operated by a private contractor in the seven nonattainment counties (Allen, Clark, Floyd, Marion, Lake, Porter, and St. Joseph). The existing certified state inspection station network will continue to perform safety inspections throughout the state, at least at the outset of the emissions inspection program. The contractor's facilities, however, will be designed so that their emission inspection function can at some future date be readily expanded to include safety inspections as well, at little additional expense. Building and land requirements are therefore calculated so as to permit this expansion.

DETERMINATION OF THE CONTRACTOR RUN NETWORK

Relevant Vehicle Population

The number of motor vehicle inspections required in 1987 for alternative 3 appears in Table 20. The figures in this table represent 1.3 times the inspected vehicle population to account for reinspections resulting from a 30 percent stringency rate.

Lane Requirements

Based on the geographic distribution of motor vehicles to be inspected in 1987 and the constraints on facility size (two to six lanes), the network of inspection facilities necessary for alternative 3 was derived; this is shown in Table 21.

CONTRACTOR NETWORK COST CONSIDERATIONS

Initial Capital Costs

These costs reflect the initial outlay required for real property and equipment purchases. There are three types of initial capital costs: land investments, building investments, and equipment costs.

TABLE 20. ANNUAL NUMBER OF INSPECTIONS REQUIRED BY COUNTY FOR 1987, ALTERNATIVE 3

County	Number of inspections required
Allen	371,238
Clark	110,528
Floyd	67,297
Lake	594,523
Marion	887,592
Porter	144,900
St. Joseph	255,959
Total	2,432,037

Note: GCA calculations, 1978.

TABLE 21. INSPECTION NETWORK REQUIREMENTS FOR ALTERNATIVE 3

Location		Required facilities	Number of lanes
County	Municipality		
Allen	Ft. Wayne	1	4
	Ft. Wayne	1	5
Clark	Charlestown	1	3
Floyd	New Albany	1	2
Lake	Gary	1	6
	Hammond	1	6
	Crown Point	1	3
Marion	Indianapolis	2	12
	Edgewood	1	5
	Lawrence	1	5
Porter	Valparaiso	1	4
St. Joseph	South Bend	1	5
	North Liberty	1	2
Total		14	62

Note: GCA calculations, 1978.

Land Investments--

Land investment costs are a function of network requirements, building area, building to lot ratios, access requirements, local zoning regulations and other miscellaneous considerations. Indiana real estate sources provided cost estimates. Land investment costs appear in Table 22.

Building Investments--

Building requirements are a function of lane area requirements (Table 2-8) that in turn are based on throughput requirements. In addition to lane area, ancillary service area and administrative space is needed as described in Section 2. Table 23 summarizes building area requirements as a function of the number of lanes per facility. It is important to keep in mind that Table 23 is based on buildings designed with extra unused capacity to allow for possible future expansion for performance of safety inspections. The network (number and location of buildings) was designed using a 2-minute throughput rate for the idle test.

Applying these costs to the network described in Table 21 yields a total building cost of $8,610,900 for alternative 3. A breakdown of building costs for the network is shown in Table 24.

Equipment Costs--

The cost of major equipment items comprises the final category of initial capital costs. The unit cost per item and remarks concerning these major items appear in Table 25.

Equipment costs as a function of facility configuration appear in Table 26. Applying these figures to the network for alternative 3 results in total equipment costs which are reported in Table 27.

One-Time Startup Costs

This cost category is comprised of monies spent for noncapital items and services on a one-time basis prior to the actual program startup.

Land Acquisition--

As discussed in Section 2, land acquisition costs are assumed to be $6,000 per site plus 10 percent of the purchase price to cover transfer expenses, title searches, etc. Based on 14 facilities, total land acquisition costs for alternative 3 are:

land acquisition cost = (14 facilities)($6000 per facility) + (0.10)($2,870,380)

= $84,000 + $287,038

= $371,038

Facilities Planning--

A facilities planning figure is computed as a function of total building construction cost. For building construction costs under $3 million, facility planning costs are 20 percent of construction costs. For costs between $3 million and $6 million, a 15 percent figure is used. For costs over

TABLE 22. LAND INVESTMENT COSTS FOR EACH FACILITY IN ALTERNATIVE 3

Location		Required facilities	Number of lanes	Lot size per facility (ft^2)	Land cost per ft^2 ($)	Cost per facility ($)	Total cost ($)	Total queue area (ft^2)	Total parking area	Total paved area	Paving cost per ft^2 ($)	Total paving cost ($)	Landscaped area	Cost per ft^2 ($)	Landscaping cost ($)	Total improvements ($)	Total land investment ($)
County	Municipality																
Allen	Ft. Wayne	1	4	90,975	2.00	181,950	181,950	20,000	6,480	26,480	0.80	21,184	46,300	0.25	11,575	32,759	214,709
	Ft. Wayne	1	5	114,680	2.00	229,360	229,360	25,000	8,100	33,100	0.80	26,480	58,645	0.25	14,661	41,141	270,501
Clark	Charlestown	1	3	68,925	2.00	137,850	137,850	15,000	4,860	19,860	0.80	15,888	35,280	0.25	8,820	24,708	162,558
Floyd	New Albany	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
Lake	Gary	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Hammond	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Crown Point	1	3	68,925	2.00	137,850	137,850	15,000	4,860	19,860	0.80	15,888	35,280	0.25	8,820	24,708	162,558
Marion	Indianapolis	2	12	139,980	2.00	279,960	559,920	60,000	19,440	79,440	0.80	63,552	144,530	0.25	36,133	99,685	659,605
	Edgewood	1	5	114,680	2.00	229,360	229,360	25,000	8,100	33,100	0.80	26,480	58,645	0.25	14,661	41,141	270,501
	Lawrence	1	5	114,680	2.00	229,360	229,360	25,000	8,100	33,100	0.80	26,480	58,645	0.25	14,661	41,141	270,501
Porter	Valparaiso	1	4	90,975	2.00	181,950	181,950	20,000	6,480	26,480	0.80	21,184	46,300	0.25	11,575	32,759	214,709
St. Joseph	South Bend	1	5	114,680	2.00	229,360	229,360	25,000	8,100	33,100	0.80	26,480	58,645	0.25	14,661	41,141	270,501
	North Liberty	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
Total		14	62				2,870,380					328,352			184,429	512,781	3,383,161

Note: GCA calculations, 1978.

TABLE 23. BUILDING FLOOR AREA REQUIREMENTS FOR VARIOUS FACILITY CONFIGURATIONS - ALTERNATIVE 3

Lane configuration	Floor area required (ft^2)						
	Test area	Administration	Employee rest	Storage	Waiting	Restrooms	Total
1	3,200	1,000	300	350	960	85	5,895
2	6,400	1,000	350	400	1,440	85	9,675
3	9,600	1,000	410	450	2,240	85	13,785
4	12,800	1,000	450	500	3,360	85	18,195
5	16,000	1,000	500	550	4,800	85	22,935
6	19,200	1,000	550	600	6,560	85	27,995

Note: GCA calculations, 1978.

TABLE 24. BUILDING COST ESTIMATES FOR ALTERNATIVE 3

Location		Facilities	Number of lanes	Building size per facility (ft^2)	Construction cost per ft^2 ($)	Cost per facility ($)	Total cost ($)
County	Municipality						
Allen	Ft. Wayne	1	4	18,195	30	545,850	545,850
	Ft. Wayne	1	5	22,935	30	688,050	688,050
Clark	Charlestown	1	3	13,785	30	413,550	413,550
Floyd	New Albany	1	2	9,675	30	290,250	290,250
Lake	Gary	1	6	27,995	30	839,850	839,850
	Hammond	1	6	27,995	30	839,850	839,850
	Crown Point	1	3	13,785	30	413,550	413,550
Marion	Indianapolis	2	12	27,995	30	839,850	1,679,700
	Edgewood	1	5	22,935	30	688,050	688,050
	Lawrence	1	5	22,935	30	688,050	688,050
Porter	Valparaiso	1	4	18,195	30	545,850	545,850
St. Joseph	South Bend	1	5	22,935	30	688,050	688,050
	North Liberty	1	2	9,675	30	290,250	290,250
Total		14	62				8,610,900

Note: GCA calculations, 1978.

TABLE 25. MAJOR EQUIPMENT ITEMS REQUIRED AND UNIT COSTS FOR ALTERNATIVE 3

Item	Remarks	Unit cost ($)
1. Emissions analyzer	Since idle mode is being used, analyzer should be capable of measuring CO and HC. Extremely wide range in costs; cheaper analyzers found to be inadequate. Analyzers should be capable of being tied into computer data handling systems. Costs based on discussions with manufacturers (Olson-Horiba, Hamilton Test Systems).*	21,500
2. Computer remote terminal or CRT	Two required per lane. Costs based on literature and discussion with manufacturers (Honeywell, Digital, Olivetti, Sperry Univac).	2,500
3. Minicomputer	One required per facility. Generally assumed to be included in facility furnishings.	80,000
4. Miscellaneous tools	As required.	1,000

*Emission analyzers costed for centralized lanes differ from garage analyzers costed at $3,000 as follows: (1) to decrease purge time to a level acceptable for a high volume application, the analyzer has refrigerated bath and filtration capabilities not available in a garage analyzer; (2) to eliminate CO_2 and H_2O interference, the centralized lane analyzer has dual detector capabilities; (3) to allow computer tie-in, the analyzer is capable of linearized output; (4) to correct for high and variable ambient concentrations of HC and CO, "flowing reference cells" are included.

Note: GCA calculations, 1978.

TABLE 26. EQUIPMENT COSTS AS A FUNCTION OF FACILITY CONFIGURATION FOR ALTERNATIVE 3

Number of lanes	Equipment cost ($)
1	107,500
2	135,000
3	162,500
4	190,000
5	217,500
6	245,000

Note: GCA calculations, 1978.

TABLE 27. EQUIPMENT COSTS FOR ALTERNATIVE 3

Location		Facilities	Number of lanes	Cost per facility ($)	Total cost ($)
County	Municipality				
Allen	Ft. Wayne	1	4	190,000	190,000
	Ft. Wayne	1	5	217,500	217,500
Clark	Charlestown	1	3	162,500	162,500
Floyd	New Albany	1	2	135,000	135,000
Lake	Gary	1	6	245,000	245,000
	Hammond	1	6	245,000	245,000
	Crown Point	1	3	162,500	162,500
Marion	Indianapolis	2	12	245,000	490,000
	Edgewood	1	5	217,500	217,500
	Lawrence	1	5	217,500	217,500
Porter	Valparaiso	1	4	190,000	190,000
St. Joseph	South Bend	1	5	217,500	217,500
	North Liberty	1	2	135,000	135,000
		14	62	-	2,825,000
Test equipment					
Central computer					250,000
Maintenance/calibration vans					84,000
Security systems					15,400
					3,174,400

Note: GCA calculations, 1978.

$6 million, facility planning is assumed to be 10 percent of construction cost. For alternative 3, facility planning costs are $861,090 or 10 percent of total building construction costs.

Program Design--

Based on both an analysis of the requirements specific to Indiana, and the experience of other states, a cost of $100,000 was arrived at for the program design estimate.

Data Handling Software--

Based on discussions with computer systems analysts, an estimate of $200,000 was developed.

Personnel Training--

As indicated in Section 2, an initial, intensive training effort is required prior to program startup. Personnel requirements for each alternative were derived from time motion - manpower data* and discussions with states and private contractors involved in I/M program operation. The allocation of personnel is:

- One manager and one assistant manager per facility
- Three inspectors per test lane for emissions testing only
- Seven inspectors per test lane for combined safety and emissions testing
- One maintenance/calibration person for every 10 lanes.

Applying these rates to the facility requirements developed previously, the basic operating personnel requirements for alternative 3 are:

- 14 managers
- 14 assistant managers
- 186 inspectors
- 6 maintenance calibration personnel

The training cost per individual, as discussed in Section 2, is $53.00, $43.00, and $16.00, respectively, for instructors, investigators, and inspectors. Assume that:

1. the managers are to be trained as instructors,
2. assistant managers are to be trained at the inspector level, and
3. inspection and maintenance/calibration personnel are to be trained at the inspector level.

---

*AVCO: DOT HS-802 499, Volume 10, Appendix I.

The total cost of training can then be computed:

(14 managers)($53.00) + (14 assistant managers)($16.00)

+ (186 inspectors)($16.00) + (6 maintenance/calibration personnel)($16.00)

= $4,038

Personnel Salaries--

Personnel costs are based on the following assumptions:

- all managerial personnel will be phased into the program 6 months prior to startup
- inspectors will be phased in 1 month prior to startup
- wage scales are:*
  - Managers, $15,000 per year or $1,250 per month
  - Assistant managers, $13,000 per year or $1,083 per month
  - Maintenance/calibration personnel, $12,000 per year or $1,000 per month
  - Inspectors, $10,000 per year or $833 per month
- 25 percent is added to these figures to cover personnel overhead

The total cost for test personnel wages can be computed for alternative 3 based on these assumptions. Test personnel costs are:

[(14 managers)($1,250/month)(6 months)

+ (14 assistant managers)(1,083/month)(6 months)

+ (6 maintenance/calibration personnel)($1,000/month)(1 month)

+ (186 inspectors)($833/month)(1 month)] 1.25 = $446,138

The administrative personnel costs must also be included in the startup phase. These persons would be phased in 18 months prior to startup for this alternative. Based on the discussion of personnel requirements and salaries presented in Section 2, the costs associated with 18 months of startup can be computed. These are shown in Table 28.

The total personnel cost for startup, then, is the total of the operational personnel and the administrative personnel costs,

or: $446,138 + 982,313 = $1,428,451

---

*State of Indiana Classification Plan and Salary Schedule, July 1977.

TABLE 28. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP - ALTERNATIVE 3

Job title	Number of positions	Annual salary per position ($)	Total 18-month salaries for all positions ($)
Administrator	1	25,000	37,500
Assistant Administrator (support)	1	17,000	25,500
Assistant Administrator (operations)	1	21,000	31,500
Legal Counsel	1	15,000	22,500
Purchasing Officer	1	13,000	19,500
Contracts Officer	1	13,000	19,500
Accountant	1	12,000	18,000
Engineer	1	10,400	15,600
Systems Analyst	1	11,000	16,500
Statistician/Programmer	1	10,500	15,750
Mechanic Training Coordinator	1	13,000	19,500
Regional Manager	5	21,500	161,250
Regional Inspector (licensing)	5	15,500	116,250
Regional Manager (surveillance)	5	15,500	116,250
Regional Public Information Coordinator	5	15,500	116,250
Mechanic Training Instructor	1	11,000	16,500
Instrument Repair Technician	1	12,000	18,000
Total salaries for 18 months			785,850
Overhead at 25 percent of salary			196,463
Total Administrative personnel costs			982,313

Note: GCA calculations, 1978.

Public Information Program--

The cost estimate for this element was based on the experiences of various states and private contractors currently involved in operating I/M programs. The basic assumption is that a budget for initial public information should be $0.12 per vehicle to be inspected, which translates to $291,844 for this alternative.

Annual Operating Costs

This cost category includes all costs associated with the actual operation of the program. Adjunctive programs such as ongoing public information and inspector/mechanic training programs are not included here.

Facility personnel--

Based on the facility staffing requirements and annual salaries associated with each job category, the annual personnel costs can be computed. This estimate is shown in Table 29.

TABLE 29. ANNUAL SALARY EXPENSE FOR FACILITY PERSONNEL

Job title	Number of positions	Annual salary per position ($)	Total annual salary for all positions ($)
Manager	14	15,000	210,000
Assistant Manager	14	13,000	182,000
Maintenance/Calibration Person	6	12,000	72,000
Inspector	186	10,000	1,860,000
Total salaries			2,324,000
Overhead at 25 percent			581,000
Total costs			2,905,000

Note: GCA calculations, 1978.

Maintenance--

Primary costs for maintenance reflect equipment repair and preventive maintenance. In this connection, the yearly cost of these items was estimated to be 20 percent of the original cost, or:

$$\$2,825,000 \times 0.20 = \$565,000$$

Utilities/Supplies/Services--

Utilities-- Annual utility costs were derived from electric usage rates experienced in other states. For alternative 3, these were found to be: 120 kWh/day for each lane, plus 325 kWh/day per facility. An average $0.04/kWh rate was obtained from Indianapolis Power and Light. The annual cost, then, is calculated below:

(62 lanes)(120 kWh/day lane)($0.04/kWh)(250 operating day/yr) = $ 74,400

+ (14 facilities)(325 kWh/day facility)($0.04/kWh)(250 operating day/yr) = 45,500

$119,900

Insurance--It is assumed that the operation would be covered by fire and theft as well as liability insurance. Based on previous experience (Arizona - HTS), insurance costs generally run about $1,500 per lane. Annual costs based on this estimate are calculated below:

(62 lanes) (1,500/lane) = $93,000

Computer operation--Central computer operation costs for automated inspection systems have been estimated at $0.15 per test. This would compute to an annual cost of $364,806 for alternative 3.

Inspection forms--In addition to the computer operation costs, a cost of $0.03 per test has been estimated based on previous experience (Arizona). This computes to a total annual cost of $72,961 for alternative 3.

Calibration costs--The recurring annual cost of equipment calibration is defined as the cost of calibration gases plus the operating cost of the maintenance/calibration vans. The total annual calibration costs for alternative 3 are outlined in Table 30, and were found to run $52,800 annually.

TABLE 30. ANNUAL CALIBRATION COSTS FOR ALTERNATIVE 3

Item	Cost ($)
Gases (20 sets per year at $200 per set)	4,000
Maintenance on van	2,800
Insurance on van and equipment	1,000
Fuel, oil, etc.	1,000
Per calibration van	8,800
× vans	6
= annually	52,800

Note: GCA calculations, 1978.

Taxes--Property tax rates have been obtained from the Indiana Board of Tax Commissioners and applied to the I/M network for alternative 3 to arrive at an annual tax figure. The results of this appear in Table 31.

Uniforms--Uniforms cost $125.00 per year, based on previous experience (Arizona). For alternative 3, this cost will be $27,500 annually for 220 uniformed employees.

Security systems--Based on the experiences of other states, the annual cost of upkeep and service of security systems is estimated to be $850 per facility. For alternative 3, then, an annual cost of $11,900 is estimated.

The costs for the utilities/supplies/services category of annual operating costs are summarized in Table 32.

Annual Administrative Costs

This cost category consists of all administrative personnel costs and public information costs.

Program Administration--

Annual administrative costs are computed from the personnel requirements and salaries, which were delineated previously. The annual cost computation is shown in Table 33.

Public Information--

The estimated cost for an annual public information program is estimated to be $0.12 per vehicle inspected or $291,844 for alternative 3.

Personnel Training--

This element reflects the ongoing requirement to train new inspectors. The replacement rate, or number of new inspectors to be trained annually, was estimated to be 10 percent of the inspection force. This is based on the experience of the Arizona program. For alternative 3, an inspector work force of 186 people implies that 19 new inspectors have to be trained annually. The cost of training each individual is estimated at $16.00. The annual cost is $304.

TOTAL ALTERNATIVE COSTS

The total costs for alternative 3 are reported in Table 34. Capital costs are $15,168,461 and one-time startup costs are $2,810,323. Ongoing annual operation and adminsitrative expenses run $4,394,590 and $947,027, respectively.

TABLE 31. TAXES - ALTERNATIVE 3[*]

Location		Facilities	Number of lanes	Value of taxable property ($)	Tax rate (percent)	Annual taxes ($)
County	Municipality					
Allen	Ft. Wayne	1	4	950,559	1.0698	10,169
	Ft. Wayne	1	5	1,176,051	1.0698	12,581
Clark	Charlestown	1	3	738,608	0.7900	5,835
Floyd	New Albany	1	2	538,957	0.6350	3,422
Lake	Gary	1	6	1,414,652	1.7442	24,674
	Hammond	1	6	1,414,652	1.8017	25,488
	Crown Point	1	3	738,608	1.1875	8,771
Marion	Indianapolis	2	12	2,829,304	1.2694	35,915
	Edgewood	1	5	1,176,051	1.1000[†]	12,937
	Lawrence	1	5	1,176,051	1.0222	12,021
Porter	Valparaiso	1	4	950,559	1.1100	10,551
St. Joseph	South Bend	1	5	1,176,051	1.2530	14,736
	North Liberty	1	2	538,957	1.0068	5,426
Total		14	62	14,819,060	-	182,529

[*] Tax rates obtained from the Indiana Board of Tax Commissioners.

[†] No figure available. County average used.

Note: GCA calculations, 1978.

TABLE 32. ANNUAL COST FOR UTILITIES/ SUPPLIES/SERVICES

Category	Annual operating cost ($)
Utilities	119,900
Insurance	93,000
Computer operation	364,000
Inspection forms	72,961
Calibration costs	52,800
Taxes	182,529
Uniforms	27,500
Security	11,900
Total	924,590

Note: GCA calculations, 1978.

TABLE 33. ANNUAL ADMINISTRATIVE PERSONNEL COSTS - ALTERNATIVE 3

Job title	Number of positions	Annual salary per position ($)	Total annual salaries for all positions ($)
Administrator	1	25,000	25,000
Assistant Administrator (support)	1	17,000	17,000
Assistant Administrator (operations)	1	21,000	21,000
Legal Counsel	1	15,000	15,000
Purchasing Officer	1	13,000	13,000
Contractor Officer	1	13,000	13,000
Accountant	1	12,000	12,000
Engineer	1	10,400	10,400
Systems Analyst	1	11,000	11,000
Statistician/Programmer	1	10,500	10,500
Mechanic Training Coordinator	1	13,000	13,000
Regional Manager	5	21,500	107,500
Regional Inspector (licensing)	5	15,500	77,500
Regional Manager (surveillance)	5	15,500	77,500
Regional Public Information Coordinator	5	15,500	77,500
Mechanic Training Instructor	1	11,000	11,000
Instrument Repair Technician	1	12,000	12,000
Total salaries			523,900
Overhead at 25 percent			130,975
Total Annual Administrative Costs			654,875

Note: GCA calculations, 1978.

TABLE 34. COST SUMMARY - ALTERNATIVE 3

Primary category	Principal element	Element cost ($)	Total category cost ($)
Capital costs	1. Land investment (includes improvements)	3,383,161	
	2. Building investment	8,610,900	
	3. Equipment costs	2,825,000	
	4. Central computer	250,000	
	5. Calibration vans (investigators)	84,000	
	6. Security systems	15,400	
Total			15,168,461
One-time startup costs	1. Land acquisition	371,038	
	2. Facilities planning	861,090	
	3. Program design	100,000	
	4. Data software development	200,000	
	5. Personnel training	4,038	
	6. Personnel salaries and overhead	1,298,732	
	7. Initial public relations	291,844	
Total			3,256,461
Annual operating costs	1. Facility personnel	2,905,000	
	2. Maintenance	565,000	
	3. Utilities, services, supplies	924,590	
Total			4,394,590
Annual administrative costs	1. Administrative salaries	654,875	
	2. Public relations	291,844	
	3. Training	304	
Total			947,027

Note: GCA calculations, 1978.

FEE COMPUTATION

The cost of an emissions inspection to motorists in the seven nonattainment counties is given by the following formula:

$$\text{Inspection fee} = \frac{\text{Total annual costs}}{\text{Total inspections required}}$$

The capital costs and startup costs presented in the previous tables are converted to annual figures by use of the amortization factors described in Section 2. Annual operating and administrative costs are then added to the annualized capital and startup costs to obtain total annual costs in real (constant) 1978 dollars. The fee, f_c, is derived by dividing the total annual costs by the annual number of paid inspections. This fee is in 1978 dollars, and thus must be increased over time to compensate for inflation.

The above fees were calculated on the assumption that retests of failed vehicles cost the same amount as initial inspections of these vehicles. If it is decided that retests should be free, the fee would be 1.3 times the above fees, since there is a 30 percent stringency factor. Table 35 presents contractor fees for alternative 3 for both paid and free retests.

TABLE 35. CONTRACTOR FEES,
ALTERNATIVE 3
(CONSTANT DOLLARS)

	$i = 0.03$	$i = 0.06$
Paid retests	3.05	3.22
Free retests	3.97	4.19

Note: GCA calculations, 1978.

POSSIBLE EXTERNALITIES AND LEGISLATIVE CONSIDERATIONS

In this section, only those issues specifically affecting alternative 3 are discussed. While no particular legal problems were found that could affect this alternative at either the state or federal level, there are notable practical and political considerations that should be kept in mind.

Alternative 3 provides emissions testing within the seven nonattainment counties. A contractor operated network will be established in this area to provide idle-mode inspections. The buildings in this contractor network have been designed with the capacity to expand to include safety inspections sometime in the future.

CALCULATION OF INSPECTION FEES IN CONSTANT DOLLARS FOR ALTERNATIVE 3*

f_c (when i=0.03)	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital Costs			
1. Land	3,383,161	0.03	101,495
2. Buildings	8,610,900	0.067	576,930
3. Equipment	3,174,400	0.2184	693,289
II. Startup Costs	3,256,461	0.2184	711,211
III. Operating Costs	4,394,590	1.0	4,394,590
IV. Administrative Costs	1,044,463	1.0	1,044,463
Total			7,424,542

$f_{c_{0.03}}$ cost per inspection = 7,424,542 /2,432,037 = 3.05

f_c (when i=0.06)	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital Costs			
1. Land	3,383,161	0.06	202,990
2. Buildings	8,610,900	0.087	749,148
3. Equipment	3,174,400	0.2374	753,603
II. Startup Costs	3,256,461	0.2374	773,084
III. Operating Costs	4,394,590	1.0	4,394,590
IV Administrative Costs	1,052,940	1.0	1,052,940
Total			7,820,442

$f_{c_{0.06}}$ cost per inspection = 7,820,442 /2,432,037 = 3.22

---

*The fee has been calculated twice using different real rates of return on capital (or the market rate of interest adjusted to compensate for the effects of inflation). Because the market rate of interest fluctuates over time, it is useful to provide a range within which the inspection fee is likely to fall.

Note: GCA calculations, 1978.

The geographic boundaries of this emissions testing area correspond to county lines. As with city limits this type of boundary relates to administrative jurisdictions and is easily understood by the general public. Establishing an I/M program in areas that have excessive air pollution is another concept that should be easy to establish in the public's mind. Thus, for alternative 3, a public information program can be designed and instituted with relative ease.

The amount of pollution in these seven counties exceeds National Ambient Air Quality Standards and is higher than it is anywhere else in the state. The greatest reduction in emissions per dollar spent can be achieved here. The higher population density in these areas makes it possible to set up large scale facilities which are more efficient, and are easier to administer than is a scattered CSIS network.

As alternative 3 is now defined, motorists who have vehicles registered within the seven nonattainment counties will have to travel to a CSIS to have a safety inspection performed and then proceed to a contractor-operated facility to undergo an emissions inspection. The "two-stop" nature of alternative 3 may generate adverse public reaction. This resistance is more likely to occur if citizens of Indiana are aware that other states (e.g., New Jersey) have established, and are now operating networks that provide combined emissions and safety inspections in one facility.

Alternative 3 provides the potential to expand to combined testing in contractor-operated facilities at a later date. If this phase in was scheduled in advance and the public was aware that the "two-stop" inspections were temporary, resistance to this approach might be lessened, though it is uncertain how significant this effect might be.

While this combination of testing within one facility will appeal to the public, the private garage industry may react unfavorably to the idea. Removing safety inspections from the existing CSIS network may be considered undesirable by affected station owners. Since the repair industry has a fair amount of lobbying power, this implication should not be treated lightly.

EMISSION REDUCTION BENEFITS

Inspection/maintenance is designed to improve ambient air quality by lowering vehicular emission levels. The magnitude of potential emissions reductions is dependent on the size of the vehicle population covered by a mandatory program. 1987 tailpipe emission reductions that would result from implementing I/M were calculated using the Environmental Protection Agency's Mobile I computer routine.

The results of these calculations appear in Tables 36 and 37. Statewide vehicle HC reductions will be 6.8 percent of 1987 non-I/M levels if the program is implemented. This figure is somewhat misleading, though. The vast majority of emission reduction benefits will occur within the seven counties in which the program operates. Reductions in emissions over 1987 non-I/M levels vary from 20.2 to 28.8 percent per county. Total vehicle HC emissions in 1987 with I/M, will be 297,008 kg daily.

TABLE 36. DAILY HYDROCARBON EMISSIONS FOR ALTERNATIVE 3 (kg/day)

Area	Heavy-duty trucks									Light-duty vehicles												All vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M auto	1987 With I/M auto	1975 LD-truck	1982 LD-truck	1987 Without I/M LD-truck	1987 With I/M LD-truck	1975 Total	1982 Total	1987 Without I/M total	1987 With I/M total	1975	1982	1987 Without I/M	1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Allen County	[illegible]	340	328	1,400	1,139	318	1,707	1,380	966	20,780	11,646	6,790	4,880	3,480	2,434	1,313	1,080	28,264	14,120	8,312	5,060	30,011	15,500	9,093	6,012	79.46	27.66
Clark County	[illegible]	730	551	385	275	163	936	1,013	[illegible]	9,888	4,885	2,830	2,080	2,380	1,897	1,217	885	12,396	6,781	4,083	2,953	13,380	7,855	4,731	3,660	72.72	22.76
Floyd County	221	100	257	151	[illegible]	57	[illegible]	419	346	3,750	2,122	1,330	930	1,111	822	563	397	4,830	2,944	1,893	1,336	5,272	3,362	2,207	1,630	68.72	30.35
Lake and Porter Counties	2,786	3,030	2,406	18,138	13,619	7,366	20,886	16,460	9,772	27,338	14,025	8,367	5,658	12,873	8,306	5,783	3,819	39,400	22,409	14,150	9,477	60,290	38,870	24,112	19,300	68.12	20.25
Marion County	1,400	1,786	1,371	15,119	11,503	7,306	16,609	13,299	8,765	76,286	39,637	23,306	16,128	10,060	7,003	4,790	3,302	86,353	46,642	28,186	19,430	102,962	59,941	36,990	26,295	72.46	25.46
St. Joseph County	305	293	221	1,720	1,136	514	2,001	1,429	735	23,507	11,169	6,126	4,190	4,299	2,462	1,600	1,100	27,806	13,831	7,728	5,290	29,827	15,260	8,467	6,083	79.86	28.05
Remainder of State	4,436	6,084	5,136	46,837	44,300	27,300	51,283	50,446	32,484	430,512	266,605	156,228	115,085	80,127	43,756	44,288	43,830	511,639	312,050	200,536	158,904	563,032	362,446	233,100	230,420	58.96	0.78
Statewide	10,000	12,400	10,139	83,600	72,230	43,300	93,000	84,630	53,400	595,800	381,900	200,250	188,380	113,920	85,010	59,780	54,330	700,730	468,760	265,030	243,318	803,670	553,370	318,780	297,000	63.05	6.05

TABLE 37. DAILY CARBON MONOXIDE EMISSIONS FOR ALTERNATIVE 3 (kg/day)

Area	Heavy-duty trucks									Light-duty vehicles												All vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M auto	1987 With I/M auto	1975 LD-truck	1982 LD-truck	1987 Without I/M LD-truck	1987 With I/M LD-truck	1975 Total	1982 Total	1987 Without I/M total	1987 With I/M total	1975	1982	1987 Without I/M	1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Allen County	1,783	1,600	1,700	15,661	20,701	11,763	17,400	30,339	13,467	164,166	107,757	59,307	36,409	24,100	21,742	13,715	9,110	188,267	129,259	73,082	43,327	205,695	164,580	86,480	56,792	72.38	35.08
Clark County	4,313	4,066	4,101	4,342	4,440	3,256	8,553	8,516	7,435	72,770	45,380	26,895	16,239	10,960	17,423	12,900	8,061	91,715	62,821	39,036	24,390	100,270	71,335	46,480	31,735	68.42	30.78
Floyd County	1,705	1,722	1,956	1,666	1,700	1,150	3,431	3,480	3,117	29,616	20,177	12,476	7,466	7,752	7,753	6,070	3,613	37,368	27,932	18,546	11,009	40,809	31,356	21,675	14,144	65.35	34.78
Lake and Porter Counties	21,607	19,299	19,800	202,350	194,080	160,986	223,951	213,359	170,816	250,431	167,000	83,712	47,180	109,035	99,313	65,271	36,732	359,476	266,909	148,983	83,882	583,887	480,323	277,790	212,630	64.15	23.48
Marion County	11,609	10,401	11,137	141,133	143,857	100,098	152,704	154,318	111,235	643,580	385,038	213,619	125,605	75,914	69,440	36,867	22,003	724,497	454,976	250,446	147,606	877,261	609,296	361,733	258,081	70.35	28.68
St. Joseph County	2,026	1,722	1,703	18,468	19,461	11,637	20,492	21,183	13,360	179,815	108,166	51,313	30,465	30,899	23,508	15,910	9,446	210,714	137,730	67,223	39,911	231,206	160,915	80,563	53,231	76.95	33.96
Remainder of State	28,439	29,662	36,789	314,414	756,653	668,301	343,853	786,315	705,070	2,880,570	2,097,570	1,365,090	1,331,080	436,735	470,011	433,750	428,969	3,317,274	2,568,350	1,779,640	1,759,969	3,660,327	3,354,665	2,484,710	2,443,019	38.13	0.08
Statewide	71,750	68,500	77,390	887,960	1,138,830	905,230	960,000	1,207,060	982,500	4,341,900	2,903,150	1,790,410	1,592,360	496,330	711,090	580,520	517,986	4,838,300	3,613,000	2,378,930	2,110,104	5,900,000	4,820,480	3,361,430	3,092,082	47.6	8.08

Reproduced from best available copy.

CO emissions in 1987 with I/M, will be 3,092,662 kg per day. This represents an 8.0 percent reduction statewide over non-I/M 1987 levels. Reductions for the seven counties vary between 23.4 and 35.6 percent per county.

It is important to note that these figures are based on I/M program impacrs on LDV emission levels only.

SECTION 6

ALTERNATIVE 4 -
- CONTRACTOR OPERATED COMBINED LOADED-MODE EMISSIONS TESTING AND SAFETY INSPECTION IN SEVEN NONATTAINMENT COUNTIES
- CERTIFIED STATE INSPECTION STATION CONDUCTED SAFETY INSPECTIONS IN THE REMAINDER OF THE STATE

ALTERNATIVE DEFINITION

This alternative provides for two separate and distinct motor vehicle inspection networks in Indiana. Within the seven nonattainment counties (Allen, Clark, Floyd, Lake, Marion, Porter, and St. Joseph), a contractor-operated network will be established. Contractor-operated stations in this network will perform combined loaded-mode emissions tests and safety inspections. In all areas outside the seven nonattainment counties, the existing certified state inspection station network will continue to perform safety inspections; no emissions testing is anticipated for these areas. Thus, in the seven nonattainment counties, responsibility for performance of safety inspections will be transferred from the existing CSIS network to the new contractor-operated facilities.

DETERMINATION OF THE CONTRACTOR-RUN NETWORK

Relevent Vehicle Population

The vehicle population that the contractor-run network is designed to cover is the projected 1987 vehicle population in the seven nonattainment counties. Designing the contractor network to cover this vehicle population assures that it will have sufficient capacity for at least the first 5 years of program operation. The 1987 inspections required appear in Table 38. This table actually represents 1.3 times the 1987 vehicle population projection to account for reinspections that will result from a planned stringency rate of 30 percent.

Lane Requirements

Based on the distribution of inspections for 1987 in Table 38 and the constraints on facility size (two to six lanes) presented in Section 2, the contractor network necessary for alternative 4 appears in Table 39. This alternative requires more lanes and facilities than does alternative 3 because more time is needed to perform a loaded-mode emissions and safety

TABLE 38. ANNUAL NUMBER OF INSPECTIONS REQUIRED BY COUNTY FOR 1987 - ALTERNATIVE 4

County	Number of inspections required
Allen	371,238
Clark	110,528
Floyd	67,297
Lake	594,523
Marion	887,592
Porter	144,900
St. Joseph	255,959
Total	2,432,037

Note: GCA calculations, 1978.

TABLE 39. INSPECTION NETWORK REQUIREMENTS FOR ALTERNATIVE 4 - CONTRACTOR APPROACH

Location		Required facilities	Number of Lanes
County	Municipality		
Allen	Ft. Wayne	3	15
	New Haven	1	5
Clark	Charlestown	1	6
Floyd	New Albany	1	4
Lake	Gary	1	6
	Hammond	1	6
	East Chicago	1	6
	Crown Point	1	6
	Orchard Grove	1	4
	Highland	1	4
Marion	Indianapolis	3	18
	Edgewood	1	6
	Lawrence	1	6
	Speedway	1	6
	Beech Grove	1	6
	South Port	1	6
Porter	Valparaiso	1	6
	Chesterton	1	2
St. Joseph	South Bend	1	6
	North Liberty	1	4
	Mishawaka	1	4
Total		25	132

Note: GCA calculations, 1978.

test than to perform an emission test without safety inspection. A loaded-mode emissions and safety test is assumed to have a 4.5 minute vehicle throughput rate, while an emission test alone has only a 2 minute throughput rate. Therefore, with combined loaded-mode testing and safety inspection, each vehicle remains in the lane 2.5 minutes longer than with emission testing only. This results in a lower annual inspection capacity per lane. Thus, to cover the same vehicle population, more lanes are necessary for combined emissions and safety inspections than for emission testing alone.

CONTRACTOR NETWORK COST CONSIDERATIONS

Initial Capital Costs

These costs are initial outlays required for real property and equipment purchases. There are three types of initial capital costs.

Land Investments--

Network requirements, building area, building-to-lot ratios, access requirements, local zoning regulations and other miscellaneous considerations all influence land investment costs. Land cost estimates were obtained from Indiana real estate sources. Land investment costs appear in Table 40.

Building Investments--

Lane area requirements (Table 3), associated administrative space and ancillary service areas determine building area needs. Based on assumptions in Section 2, building area as a function of the number of lanes in a facility appear in Table 41.

Based on the building cost assumptions in Section 2, facility space requirements (Table 41), and alternative 4 network requirements (Table 39), building cost estimates can be derived. They appear in Table 42.

Equipment Costs--

The unit cost of equipment needed as well as remarks about major equipment items appear in Table 43.

Equipment costs are summarized as a function of the number of lanes per facility in Table 44. Applying these figures to the network required for alternative 4 yields total equipment costs. These figures are reported in Table 45.

One-time Startup Costs

Expenditures for noncapital items and services that occur on a one-time basis prior to the actual program startup comprise this cost category.

Land Acquisition--

Land acquisition costs are assumed to be $6,000 per site plus 10 percent of the purchase price to cover title searches, transfer expenses, etc.

TABLE 40. LAND INVESTMENTS IN ALTERNATIVE 4

Location		Required facilities	Number of lanes	Lot size per facility (ft²)	Land cost per ft² ($)	Cost per facility ($)	Total cost ($)	Total queue area (ft²)	Total parking area	Total paved area	Paving cost per ft² ($)	Total paving cost ($)	Landscaped area	Cost per ft² ($)	Landscaping cost ($)	Total improvements ($)	Total land investment ($)
County	Municipality																
Allen	Ft. Wayne	3	15	114,680	2.00	229,360	688,080	75,000	24,300	99,300	0.80	79,440	173,935	0.25	43,484	122,924	811,004
	New Haven	1	5	114,680	2.00	229,360	229,360	25,000	8,100	33,100	0.80	26,480	58,645	0.25	14,661	41,141	270,501
Clark	Charlestown	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
Floyd	New Albany	1	4	90,975	2.00	181,950	181,950	20,000	6,480	26,480	0.80	21,184	46,300	0.25	11,575	32,759	214,709
Lake	Gary	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Hammond	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	East Chicago	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Crown Point	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Orchard Grove	1	4	90,975	2.00	181,950	181,950	20,000	6,480	26,480	0.80	21,184	46,300	0.25	11,575	32,759	214,709
	Highland	1	4	90,975	2.00	181,950	181,950	20,000	6,480	26,480	0.80	21,184	46,300	0.25	11,575	32,759	214,709
Marion	Indianapolis	3	18	139,980	2.00	279,960	839,880	90,000	29,160	119,160	0.80	95,328	216,795	0.25	54,199	149,527	989,407
	Edgewood	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Lawrence	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Speedway	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Beech Grove	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	South Port	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
Porter	Valparaiso	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Chesterton	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
St. Joseph	South Bend	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	North Liberty	1	4	90,975	2.00	181,950	181,950	20,000	6,480	26,480	0.80	21,184	46,300	0.25	11,575	32,759	214,709
	Mishawaka	1	4	90,975	2.00	181,950	181,950	20,000	6,480	26,480	0.80	21,184	46,300	0.25	11,575	32,759	214,709
Total		25	132				6,123,340					699,072			393,876	1,092,948	7,216,288

Note: OCA calculations, 1978.

TABLE 41. BUILDING FLOOR AREA FOR VARIOUS FACILITY CONFIGURATIONS — ALTERNATIVE 4

Number of Lanes	Floor area required (ft^2)						
	Test area	Administration	Employee rest	Storage	Waiting	Restrooms	Total
1	3,200	1,000	300	350	960	85	5,895
2	6,400	1,000	350	400	1,440	85	9,675
3	9,600	1,000	410	450	2,240	85	13,785
4	12,800	1,000	450	500	3,360	85	18.195
5	16,000	1,000	500	550	4,800	85	22,935
6	19,200	1,000	550	600	6,560	85	27,995

Note: GCA calculations, 1978.

Reproduced from best available copy.

TABLE 42. BUILDING COST ESTIMATES FOR ALTERNATIVE 4

Location		Facilities	Number of Lanes	Building size per facility (ft^2)	Construction cost per ft^2 ($)	Cost per facility ($)	Total cost ($)
County	Municipality						
Allen	Ft. Wayne	3	15	22,935	30	688,050	2,064,150
	New Haven	1	5	22,935	30	688,050	688,050
Clark	Charlestown	1	6	27,995	30	839,850	839,850
Floyd	New Albany	1	4	18,195	30	545,850	545,850
Lake	Gary	1	6	27,995	30	839,850	839,850
	Hammond	1	6	27,995	30	839,850	839,850
	East Chicago	1	6	27,995	30	839,850	839,850
	Crown Point	1	6	27,995	30	839,850	839,850
	Orchard Grove	1	4	18,195	30	545,850	545,850
	Highland	1	4	18,195	30	545,850	545,850
Marion	Indianapolis	3	18	27,995	30	839,850	2,519,550
	Edgewood	1	6	27,995	30	839,850	839,850
	Lawrence	1	6	27,995	30	839,850	839,850
	Speedway	1	6	27,995	30	839,850	839,850
	Beech Grove	1	6	27,995	30	839,850	839,850
	South Port	1	6	27,995	30	839,850	839,850
Porter	Valparaiso	1	6	27,995	30	839,850	839,850
	Chesterton	1	2	9,675	30	290,250	290,250
St. Joseph	South Bend	1	6	27,995	30	839,850	839,850
	North Liberty	1	4	18,195	30	545,850	545,850
	Mishawaka	1	4	18,195	30	545,850	545,850
Total		25	132				18,369,450

Note: GCA calculations, 1978.

TABLE 43. MAJOR EQUIPMENT ITEMS REQUIRED FOR ALTERNATIVE 4

Program element	Item	Remarks	Unit cost ($)
I. Emissions	1. Chassis dynamometer	Needed for loaded-mode emission test. One unit per test lane required. Cost based on conversations with manufacturers (Clayton, Maxwell).	14,000
	2. Emission analyzer	Since loaded-mode is used, analyzer should be capable of measuring CO, HC, and NO_x. Extremely wide range in analyzer costs; cheaper analyzers found to be inadequate. Analyzers should be capable of being tied into computer data handling system. Costs based on discussions with manufacturers (Olson-Horiba, Hamilton Test Systems). One unit per test lane required.	26,500
II. Safety	1. Dynamic brake tester	Analyzes relative and overall braking effort. One required per lane. Costs based on discussion with manufacturer's representative (Clayton, Hofman, Bear, Sun, Maxwell, Weaver).	14,000
	2. Scuff gauges	One required per lane. Cost estimate based on discussion with manufacturer's representative (AAMCO, Weaver).	800
	3. Headlight-aim photocell	One system required per lane. Cost based on discussion with manufacturer's representative (Hunter, Bear).	625
	4. Chassis lift	One required per lane. Cost based on discussion with manufacturer's representative (AAMCO).	4,000
III. Data systems	1. CRT Terminals	Two required per lane. Costs based on literature and discussions with manufacturer's representatives (Honeywell, Digital, Olivetti, Sperry Univac), and experiences of other states.	2,500
	2. Minicomputer	One required per facility (equivalent to Digital PDP-11-05). Generally assumed to be included in the cost of facility furnishings.	80,000
IV. Miscellaneous	1. Miscellaneous tools	As required.	1,000

Note: GCA calculations, 1978.

TABLE 44. EQUIPMENT COSTS AS A FUNCTION OF FACILITY CONFIGURATION FOR ALTERNATIVE 4

Number of lanes	Equipment cost ($)
1	145,925
2	211,850
3	277,775
4	343,700
5	409,625
6	475,550

Note: GCA calculations, 1978.

TABLE 45. EQUIPMENT COSTS FOR ALTERNATIVE 4

Location		Facilities	Number of Lanes	Cost per facility ($)	Total cost ($)
County	Municipality				
Allen	Ft. Wayne	3	15	409,625	1,228,875
	New Haven	1	5	409,625	409,625
Clark	Charlestown	1	6	475,550	475,550
Floyd	New Albany	1	4	343,700	343,700
Lake	Gary	1	6	475,550	475,550
	Hammond	1	6	475,550	475,550
	East Chicago	1	6	475,550	475,550
	Crown Point	1	6	475,550	475,550
	Orchard Grove	1	4	343,700	343,700
	Highland	1	4	343,700	343,700
Marion	Indianapolis	3	18	475,550	1,426,650
	Edgewood	1	6	475,550	475,550
	Lawrence	1	6	475,550	475,550
	Speedway	1	6	475,550	475,550
	Beech Grove	1	6	475,550	475,550
	South Port	1	6	475,550	475,550
Porter	Valparaiso	1	6	475,550	475,550
	Chesterton	1	2	211,850	211,850
St. Joseph	South Bend	1	6	475,550	475,550
	North Liberty	1	4	343,700	343,700
	Mishawaka	1	4	343,700	343,700
Total		25	132	-	10,702,100
Test equipment					
Central computer					250,000
Maintenance/calibration vans					182,000
Security systems					27,500
					11,161,600

Note: GCA calculations, 1978.

Alternative 4 requires 25 sites which reflect a total cost for land of $6,123,340 before improvements. The acquisition cost is thus:

land acquisition cost = (25 facilities)($6000 per facility) + (0.10)($6,123,340)
= $150,000 + $612,334
= $762,334

Facilities Planning--

Building costs for alternative 4 are $18,369,450. For building costs in excess of $6 million, facility planning costs are presumed to be 10 percent of building costs. Thus, for alternative 4, facility planning costs are estimated to be $1,836,945.

Program Design--

Based on both an analysis of the likely requirements specific to Indiana, and the experience of other states, a cost of $100,000 was arrived at for the program design estimate.

Data Handling Software--

Based on discussions with computer systems analysts, an estimate of $200,000 was developed for data handling software needed.

Personnel Training--

As indicated in Section 2, an initial, intensive training effort is required prior to program startup. Personnel requirements for each alternative were derived from time motion - manpower data* and discussions with states and private contractors involved in I/M program operation. The allocation of personnel are:

- One manager and one assistant manager per facility
- Three inspectors per test lane for emissions testing only
- Seven inspectors per test lane for combined safety and emissions testing
- One maintenance calibration person for every 10 lanes

Applying these rates to the facility requirements developed previously, the basic operating personnel requirements for alternative 4 are:

- 25 managers
- 25 assistant managers
- 924 inspectors
- 13 maintenance calibration personnel

---

*AVCO: DOT HS-802 499, Volume 10, Appendix I.

The training cost per individual, as discussed in Section 2, is \$53.00, \$43.00, and \$16.00, respectively, for instructors, investigators, and inspectors. Assume that:

(1) the managers are to be trained as instructors,

(2) assistant managers are to be trained at the inspector level, and

(3) inspection and maintenance/calibration personnel are to be trained at the inspector level.

The total cost of training can then be computed:

(25 managers)(\$53.00) + (25 assistant managers)(\$16.00)
+ (924 inspectors)(\$16.00) + (13 maintenance/calibration personnel)(\$16.00)
= \$16,717

Personnel Salaries--

Personnel costs are based on the following assumptions:

- all managerial personnel will be phased into the program 6 months prior to startup
- inspectors will be phased in 1 month prior to startup
- wage scales are:*
  - Managers, \$15,000 per year or \$1,250 per month
  - Assistant Managers, \$13,000 per year or \$1,083 per month
  - Maintenance/calibration personnel, \$12,000 per year or \$1,000 per month
  - Inspectors, \$10,000 per year or \$833 per month
- 25 percent is added to these figures to cover personnel overhead

The total cost for test personnel wages can be computed for alternative 4 based on these assumptions. Test personnel costs are:

[(25 managers)(\$1,250/month)(6 months)
+ (25 assistant managers)(\$1,083/month)(6 months)
+ (13 maintenance/calibration personnel)(\$1,000/month)(1 month)
+ (924 inspectors)(\$833/month)(1 month)] 1.25 = \$1,132,642

---

*State of Indiana Classification Plan and Salary Schedule, July 1977.

The administrative personnel costs must also be included in the startup phase. These positions will be phased in 18 months prior to startup for this alternative. Based on the discussion of personnel requirements and salaries presented in Section 2, the costs associated with 18 months of startup can be computed. These are shown in Table 46.

The total personnel cost for the startup phase, then, is the total of operational personnel costs and administrative personnel costs, or:

$$\$1,132,642 + 982,313 = \$2,114,955$$

Public Information Program--

The cost estimate for this element was based on the experiences of various states and private contractors currently involved in operating I/M programs. The basic assumption is that a one time startup program budget for initial public information should be approximately $0.12 per vehicle to be inspected, or for alternative 4, $291,844.

Annual Operating Costs

This cost category includes all costs associated with actual program operation. Administrative programs such as ongoing public information and inspector/mechanic training programs are not included here.

Facility personnel--

Based on the facility staffing requirements and annual salaries associated with each job category, the annual personnel costs can be easily computed. This estimate is shown in Table 47.

Maintenance--

Primary costs for maintenance reflect equipment repair and preventive maintenance. In this connection, the yearly cost of these items was estimated to be 20 percent of the original cost. Specifically, this would be:

$$\$10,702,100 \times 0.20 = \$2,140,420$$

Utilities/Supplies/Services--

Utilities--Annual cost for utilities were derived from electric usages experienced by other states. For alternative 4, these were found to be: 166 kWh/day for each lane, plus 325 kWh/day for each facility. The per kilowatt costs were obtained from Indianapolis Power and Light, and were found to be $0.04/kWh on average. The annual cost, then, is calculated below.

$$\begin{array}{rr}
\text{(132 lanes)(166 kWh/day lane)(\$0.04/kWh)(250 day/yr)} = & \$219,120 \\
+ \text{ (25 facilities)(325 kWh/day facility)(\$0.04/kWh)(250 day/yr)} = & 81,250 \\
\hline
 & \$300,370
\end{array}$$

TABLE 46. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP — ALTERNATIVE 4

Job title	Number of positions	Annual salary per position ($)	Total 18-month salaries for all positions ($)
Administrator	1	25,000	37,500
Assistant Administrator (support)	1	17,000	25,500
Assistant Administrator (operations)	1	21,000	31,500
Legal Counsel	1	15,000	22,500
Purchasing Officer	1	13,000	19,500
Contracts Officer	1	13,000	19,500
Accountant	1	12,000	18,000
Engineer	1	10,400	15,600
Systems Analyst	1	11,000	16,500
Statistician/Programmer	1	10,500	15,750
Mechanic Training Coordinator	1	13,000	19,500
Regional Manager	5	21,500	161,250
Regional Inspector (licensing)	5	15,500	116,250
Regional Manager (surveillance)	5	15,500	116,250
Regional Public Information Coordinator	5	15,500	116,250
Mechanic Training Instructor	1	11,000	16,500
Instrument Repair Technician	1	12,000	18,000
Total salaries for 18 months			785,850
Overhead at 25 percent of salary			196,463
Total Administrative personnel costs			982,313

Note: GCA calculations, 1978.

Reproduced from best available copy.

TABLE 47. ANNUAL SALARY EXPENSE FOR FACILITY PERSONNEL

Job title	Number of positions	Annual salary per position ($)	Total annual salary for all positions ($)
Manager	25	15,000	375,000
Assistant Manager	25	13,000	325,000
Maintenance/Calibration Personnel	13	12,000	156,000
Inspector	924	10,000	9,240,000
Total salaries			10,421,000
Overhead at 25 percent			2,605,250
Total costs			13,026,250

Note: GCA calculations, 1978.

Insurance--It is assumed that the operation would cover fire and theft as well as liability insurance. Based on previous experience (Arizona, HTS), insurance costs generally run about $1,500 per lane. Annual costs based on this estimate are calculated below:

(132 lanes)($1,500/lane) = $198,000

Computer operation--Central computer operation costs for automated inspection systems have been estimated at $0.15 per test. This would compute to an annual cost of $364,806 for alternative 4.

Inspection forms--In addition to the computer operation costs, a cost of $0.03 per test for inspection forms has been estimated based on previous experience (Arizona). This computes to a total annual cost of $72,961 for alternative 4.

Calibration costs--The recurring annual cost of equipment calibration is defined as the cost of calibration gases plus the operating cost of the maintenance/calibration vans. The total annual calibration costs for alternative 4 are outlined in Table 48, and were found to be $114,400.

TABLE 48. ANNUAL CALIBRATION COSTS FOR ALTERNATIVE 4

Item	Cost ($)
Gases (20 sets per year at $200 per set)	4,000
Maintenance on van	2,800
Insurance on van and equipment	1,000
Fuel, oil, etc.	1,000
Per calibration van	8,800
× vans	13
= annually	114,400

Note: GCA calculations, 1978.

Taxes--Property tax rates have been obtained from the Indiana Board of Tax Commissioners and applied to the I/M network specified for alternative 4. The results of these calculations appear in Table 49.

Uniforms--Uniforms cost $125.00 per year per employee, based on previous experience (Arizona). For alternative 4, this amounts to $123,375 for 987 uniformed employees.

Security systems--Based on experiences of other states, the annual cost for upkeep and service of security systems is $850 per facility. This cost for alternative 4 is estimated to be $21,250.

TABLE 49. ANNUAL TAXES FOR EACH FACILITY IN ALTERNATIVE 4*

Location		Facilities	Number of Lanes	Value of taxable property ($)	Tax rate (percent)	Annual taxes ($)
County	Municipality					
Allen	Ft. Wayne	3	15	4,104,529	1.0698	43,910
	New Haven	1	5	1,368,176	0.9896	13,539
Clark	Charlestown	1	6	1,645,202	0.7900	12,997
Floyd	New Albany	1	4	1,104,259	0.6350	7,012
Lake	Gary	1	6	1,645,202	1.7442	28,696
	Hammond	1	6	1,645,202	1.8017	29,642
	East Chicago	1	6	1,645,202	1.2366	20,345
	Crown Point	1	6	1,645,202	1.1875	19,537
	Orchard Grove	1	4	1,[illegible]04,259	1.3682†	15,108
	Highland	1	4	1,104,259	1.4659	16,187
Marion	Indianapolis	3	18	4,935,606	1.2694	62,653
	Edgewood	1	6	1,645,202	1.1000†	18,097
	Lawrence	1	6	1,645,202	1.0222	16,817
	Speedway	1	6	1,645,202	0.7821	12,867
	Beech Grove	1	6	1,645,202	1.2499	20,563
	South Port	1	6	1,645,202	0.9927	16,332
Porter	Valparaiso	1	6	1,645,202	1.1100	18,262
	Chesterton	1	2	615,807	0.8630	5,314
St. Joseph	South Bend	1	6	1,645,202	1.2530	20,614
	North Liberty	1	4	1,104,259	1.0068	11,118
	Mishawaka	1	4	1,104,259	1.1050	12,202
Total		25	132	36,287,837		421,812

*Tax rates obtained from the Indiana Board of Tax Commissioners.

†No figure available. County average used.

Note: GCA calculations, 1978.

The costs for the utilities/services/supplies category of annual operating costs are summarized in Table 50.

TABLE 50. ANNUAL COST FOR UTILITIES/SERVICES/SUPPLIES

Category	Annual operating cost ($)
Utilities	300,370
Insurance	198,000
Computer operation	364,806
Inspection forms	72,961
Calibration costs	114,400
Taxes	421,812
Uniforms	123,375
Security systems	21,250
Total	1,616,974

Note: GCA calculations, 1978.

Annual Administrative Costs

All administrative personnel costs and ongoing public information expenses are included in this category.

Program Administration--

Annual adminsitrative personnel costs are computed from alternative 4 personnel requirements and employee salaries delineated previously. The annual cost computation is shown in Table 51.

Public Information--

A $0.12 per vehicle inspected public information program cost is assumed. This annual cost is $291,844 for alternative 4.

Personnel Training--

This element reflects the ongoing requirement to train new inspectors. A replacement rate of 10 percent has been assumed in previous sections. The work force of 924 inspectors relates to an annual replacement of 92 new inspectors. The cost for each individual to be trained is assumed to be approximately $16. Therefore, the entire cost is:

(92 inspectors)($16 per inspector) = $1,472

TABLE 51. ANNUAL ADMINISTRATIVE PERSONNEL COSTS — ALTERNATIVE 4

Job title	Number of positions	Annual salary per position ($)	Total annual salaries for all positions ($)
Administrator	1	25,000	25,000
Assistant Administrator (support)	1	17,000	17,000
Assistant Administrator (operations)	1	21,000	21,000
Legal Counsel	1	15,000	15,000
Purchasing Officer	1	13,000	13,000
Contractor Officer	1	13,000	13,000
Accountant	1	12,000	12,000
Engineer	1	10,400	10,400
Systems Analyst	1	11,000	11,000
Statistician/Programmer	1	10,500	10,500
Mechanic Training Coordinator	1	13,000	13,000
Regional Manager	5	21,500	107,500
Regional Inspector (licensing)	5	15,500	77,500
Regional Manager (surveillance)	5	15,500	77,500
Regional Public Information Coordinator	5	15,500	77,500
Mechanic Training Instructor	1	11,000	11,000
Instrument Repair Technician	1	12,000	12,000
Total salaries			523,900
Overhead at 25 percent			130,975
Total Annual Administrative Costs			654,875

Note: GCA calculations, 1978.

TOTAL ALTERNATIVE COSTS

Table 52 reports the total costs for alternative 4. They are broken down into the major cost categories as they are discussed above. Capital costs are $36,747,338 and one-time startup costs are $5,322,795. Ongoing annual operation and administrative expenses total $16,783,644 and $948,191, respectively.

TABLE 52. COST SUMMARY - ALTERNATIVE 4

Primary category	Principal element	Element cost ($)	Total category cost ($)
Capital costs	1. Land investment (includes improvements)	7,216,288	
	2. Building investment	18,369,450	
	3. Equipment costs	10,702,100	
	4. Central computer	250,000	
	5. Calibration vans (investigators)	182,000	
	6. Security systems	27,500	
Total			36,747,338
One-time startup costs	1. Land acquisition	762,334	
	2. Facilities planning	1,836,945	
	3. Program design	100,000	
	4. Data software development	200,000	
	5. Personnel training	16,717	
	6. Personnel salaries and overhead	2,114,955	
	7. Initial public relations	291,844	
Total			5,322,795
Annual operating costs	1. Facility personnel	13,026,250	
	2. Maintenance	2,140,420	
	3. Utilities, services, supplies	1,616,974	
Total			16,783,644
Annual administrative costs	1. Administrative salaries	654,875	
	2. Public relations	291,844	
	3. Training	1,472	
Total			948,191

Note: GCA calculations, 1978.

FEE COMPUTATION

The cost of an emissions inspection to motorists in the seven nonattainment counties is given by the following formula:

$$\text{Inspection fee} = \frac{\text{Total annual costs}}{\text{Total inspections required}}$$

The capital costs and startup costs presented in the previous tables are converted to annual figures by use of the amortization factors described in Section 2. Annual operating and administrative costs are then added to the annualized capital and startup costs to obtain total annual costs in real (constant) 1978 dollars. The fee, f_c, is derived by dividing the total annual costs by the annual number of paid inspections. This fee is in 1978 dollars, and thus must be increased over time to compensate for inflation. For alternative 4, f_c is presented in Table 53.

TABLE 53. CONTRACTOR INSPECTION FEE CALCULATION, ALTERNATIVE 4, 1987 (CONSTANT 1978 DOLLARS)

	f_c (when i=0.03)	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital Costs			
	1. Land	7,216,288	0.03	216,489
	2. Buildings	18,369,450	0.067	1,230,753
	3. Equipment	11,161,600	0.2184	2,437,693
II.	Startup Costs	5,322,795	0.2184	1,162,498
III.	Operating Costs	16,783,644	1.0	16,783,644
IV.	Administrative Costs	948,191	1.0	948,191
	Total			22,779,268

$f_{c_{0.03}}$ cost per inspection = 22,779,268 /2,432,037 =9.366

	f_c (when i=0.06)	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital Costs			
	1. Land	7,216,288	0.06	432,977
	2. Buildings	18,369,450	0.087	1,598,142
	3. Equipment	11,161,600	0.2374	2,649,764
II.	Startup Costs	5,322,795	0.2374	1,263,632
III.	Operating Costs	16,783,644	1.0	16,783,644
IV.	Administrative Costs	948,191	1.0	948,191
	Total			23,676,350

$f_{c_{0.06}}$ cost per inspection = 23,676,350 /2,432,037 =9.735

Note: GCA calculations, 1978.

If the administrative decision is made that all retests of failed vehicles will be performed free of charge, then all registered vehicles must pay an inspection fee which is slightly higher than those calculated above to defray the costs of performing the free reinspections. Table 54 shows contractor inspection fees for paid and free retests.

TABLE 54. CONTRACTOR INSPECTION FEES,
ALTERNATIVE 4, 1987
(CONSTANT 1978 DOLLARS)

	i = 0.03	i = 0.06
Paid retests	9.366	9.735
Free retests	12.176	12.656

Note: GCA calculations, 1978.

POSSIBLE EXTERNALTIES AND LEGISLATIVE CONSIDERATIONS

In this section, only those issues specifically affecting alternative 4 are discussed. No particular legal problems were encountered that could affect this alternative at either the state or federal level, but there are notable practical and political issues that should be considered.

This alternative establishes emissions testing within seven nonattainment counties only. These will be conducted along with safety inspections by a contractor-operated inspection network. The remainder of Indiana will not be included in an I/M program, but will continue to be covered by the existing CSIS administered safety inspection program.

The geographic bounds for alternative 4 emissions testing correspond to county lines. The public is aware of and understands that county lines are used for administrative purposes. Establishing an I/M program in counties that have severe air pollution problems is a logical concept. The public should readily understand and accept it. Thus, while a well-designed public information program is important, it can be designed for alternative 4 at a reasonable cost.

This alternative combines emissions and safety inspections within one facility. The one-stop nature of this approach will appeal to the public, but the private garage industry may react unfavorably. Transferring safety inspections to contractor-operated facilities within the seven county area will cause CSIS inspections to drop off by almost 40 percent. Since the repair industry has a fair amount of lobbying influence, this implication of alternative 4 should not be treated lightly.

EMISSION REDUCTION BENEFITS

Inspection/maintenance is designed to improve ambient air quality by lowering vehicular emission levels. The magnitude of potential emissions reductions is dependent on the size of the vehicle population covered by a mandatory program. The 1987 tailpipe emission reductions that would result from implementing I/M were calculated using the Environmental Protection Agency's Mobile I computer routine.

The results of these calculations appear in Tables 55 and 56. Statewide vehicle HC reductions will be 6.8 percent of 1987 non-I/M levels if the program is implemented. This figure is somewhat misleading, though. The vast majority of emission reduction benefits will occur with the seven counties in which the program operates. Reductions in emissions over 1987 non-I/M levels vary from 20.2 to 27.0 percent per county. Total vehicle HC emissions in 1987 with I/M, will be 297,008 kg daily.

CO emissions in 1987 with I/M, will be 3,092,662 kg per day. This represents an 8.0 percent reduction statewide over non-I/M 1987 levels. Reductions for the seven counties vary between 23.4 and 35.6 percent per county.

TABLE 55. DAILY HYDROCARBON EMISSIONS FOR ALTERNATIVE 4 (kg/day)

Area	Heavy-duty trucks									Light-duty vehicles												All vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M auto	1987 With I/M auto	1975 LD-truck	1982 LD-truck	1987 Without I/M LD-truck	1987 With I/M LD-truck	1975 Total	1982 Total	1987 Without I/M total	1987 With I/M total	1975	1982	1987 Without I/M	1987 With I/M	Percent reduction 1975 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Allen County	279	249	128	1,488	1,139	516	1,767	1,388	644	22,780	11,666	6,799	4,880	3,484	2,454	1,313	1,088	26,264	14,120	8,112	5,968	28,031	15,508	9,055	6,612	76.4%	27.0%
Clark County	593	738	533	383	275	163	976	1,013	696	9,604	4,895	2,808	2,060	2,788	1,897	1,217	893	12,392	6,792	4,025	2,953	13,368	7,805	4,721	3,649	72.7%	22.7%
Floyd County	251	310	257	151	109	57	402	419	314	3,759	2,122	1,330	939	1,111	822	563	397	4,870	2,944	1,893	1,336	5,272	3,363	2,207	1,650	68.7%	25.2%
Lake and Porter Counties	2,766	3,030	2,466	18,130	13,419	7,306	20,896	16,449	9,772	27,332	14,023	8,567	5,656	12,073	8,386	5,783	3,819	39,405	22,409	14,350	9,475	60,301	38,858	24,122	19,247	68.1%	20.2%
Marion County	1,488	1,786	1,371	15,119	11,533	7,394	16,607	13,319	8,765	76,284	39,637	23,394	16,128	10,069	7,005	4,790	3,302	86,353	46,642	28,184	19,430	102,960	59,961	36,949	28,195	72.6%	23.6%
St. Joseph County	281	293	221	1,720	1,136	514	2,001	1,429	735	23,527	11,168	6,124	4,190	4,279	2,463	1,608	1,100	27,806	13,631	7,732	5,290	29,807	15,060	8,467	6,025	79.8%	28.8%
Remainder of State	6,436	6,854	5,136	44,837	43,590	27,508	51,273	50,444	32,644	432,512	248,607	156,224	155,025	80,127	63,396	44,310	43,959	512,639	312,003	200,534	198,984	563,912	362,616	233,178	231,628	58.9%	0.7%
Statewide	10,090	12,400	10,190	83,830	72,230	43,300	93,920	84,630	53,490	595,820	331,920	205,250	168,780	113,930	86,820	59,780	56,530	709,750	418,740	265,030	243,310	803,670	503,370	318,780	297,088	63.0%	6.8%

TABLE 56. DAILY CARBON MONOXIDE EMISSIONS FOR ALTERNATIVE 4 (kg/day)

Area	Heavy-duty trucks									Light-duty vehicles												All vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M auto	1987 With I/M auto	1975 LD-truck	1982 LD-truck	1987 Without I/M LD-truck	1987 With I/M LD-truck	1975 Total	1982 Total	1987 Without I/M total	1987 With I/M total	1975	1982	1987 Without I/M	1987 With I/M	Percent reduction 1975 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Allen County	1,783	1,628	1,702	15,641	18,701	11,765	17,424	20,329	13,467	164,167	102,517	59,367	34,409	24,100	21,762	15,715	9,118	188,267	124,279	75,082	43,527	205,691	144,608	88,549	56,994	72.3%	35.6%
Clark County	4,213	4,070	4,181	4,342	4,448	3,254	8,555	8,518	7,435	72,770	45,388	26,083	16,239	18,945	17,433	12,948	8,061	91,715	62,821	39,031	24,300	100,270	71,339	46,466	31,735	68.4%	31.7%
Floyd County	1,785	1,772	1,958	1,666	1,708	1,159	3,451	3,480	3,117	29,616	20,177	10,676	7,666	7,752	7,755	7,878	3,363	37,368	27,932	18,554	11,029	40,819	31,334	21,671	14,146	65.3%	34.7%
Lake and Porter Counties	21,697	19,299	19,030	202,254	194,060	108,986	223,951	213,359	128,016	259,451	167,869	83,712	47,130	109,025	99,115	65,271	36,732	368,476	266,984	148,983	83,862	592,427	480,343	276,999	211,878	64.1%	23.4%
Marion County	11,609	10,491	11,157	141,155	143,827	100,098	152,764	154,318	111,255	645,583	385,536	213,619	125,681	78,914	69,440	36,847	22,003	724,497	454,976	250,466	147,684	877,261	609,294	361,721	258,939	70.5%	28.4%
St. Joseph County	2,036	1,722	1,703	18,460	19,461	11,637	20,496	21,183	13,340	179,815	104,226	51,313	30,465	30,899	23,506	15,910	9,446	210,714	127,732	67,223	39,911	231,210	148,915	80,563	53,251	76.9%	33.9%
Remainder of State	38,639	29,662	36,769	516,414	756,653	668,301	555,053	786,315	705,070	2,890,539	2,097,539	1,345,898	1,331,000	426,735	470,811	433,750	428,969	3,317,274	2,568,350	1,779,648	1,759,969	3,872,327	3,354,665	2,484,718	2,465,039	36.3%	0.8%
Statewide	71,750	68,490	77,290	897,940	1,138,950	905,210	969,690	1,207,440	982,500	4,261,960	2,901,130	1,792,410	1,592,260	696,350	711,890	586,520	517,926	4,958,310	3,613,040	2,378,930	2,110,186	5,928,000	4,820,480	3,361,430	3,092,686	47.8%	8.0%

Reproduced from best available copy.

SECTION 7

ALTERNATIVE 5 -

- CONTRACTOR OPERATED IDLE-MODE EMISSIONS INSPECTION IN FIVE URBANIZED AREAS
- CERTIFIED STATE INSPECTION STATION OPERATED EXISTING SAFETY INSPECTIONS IN FIVE URBANIZED AREAS
- CERTIFIED STATE INSPECTION STATION OPERATED COMBINED IDLE-MODE EMISSIONS TESTING AND SAFETY INSPECTIONS IN RURAL PORTIONS OF SEVEN NONATTAINMENT COUNTIES
- CERTIFIED STATE INSPECTION STATION OPERATED EXISTING SAFETY INSPECTION ONLY IN THE REMAINDER OF THE STATE

ALTERNATIVE DEFINITION

In alternative 5 it is proposed that idle mode emissions testing be performed in seven nonattainment counties (Allen, Clark, Floyd, Lake, Marion, Porter and St. Joseph) and in those portions of Elkhart, Hamilton and Johnson Counties that are included within the boundaries of the five urbanized areas (Indianapolis, Louisville, South Bend, Fort Wayne and Gary). Safety inspections will be performed throughout the state.

The five urbanized areas cover portions of seven nonattainment counties and small sections of three additional counties. Those parts of the seven nonattainment counties that are not included in the five urbanized areas are considered rural (see Figure 3). In these rural portions, certified state inspection stations (CSIS) will perform combined idle mode emissions and safety inspections.

In the five urbanized areas, a contractor operated idle mode emissions testing network will be established. The certified state inspection station network that is already in place in these areas will continue to perform existing safety inspections. Thus, vehicles included in an I/M program within the five urbanized areas will be required to travel to two separate locations to have both an emissions test and a safety inspection performed.

In the nonurbanized sections of Elkhart, Hamilton and Johnson Counties, as well as in the remainder of the state, the existing safety inspection program will continue to be carried out by the CSIS network that already exists. No emissions testing will be required outside of the seven nonattainment counties and those parts of the five urbanized areas that fall outside the seven nonattainment counties.

Thus, alternative 5 defines three different areas of geographic program coverage. In five urbanized areas, both a contractor-operated network of emissions testing facilities and a CSIS network performing safety inspections will be used. In the rural portions of seven nonattainment counties, the existing CSIS network will perform combined emissions and safety inspections. Finally, the remainder of the state will be covered by a safety inspection program carried out by the existing CSIS network.

The contractor-run facilities have been designed and costed to provide the physical capacity to expand to include safety inspections in the future.

DETERMINATION OF THE CONTRACTOR RUN NETWORK

Relevant Vehicle Population

The contractor-operated emissions testing network covers five urbanized areas in alternative 5. The 1987 vehicle population in those areas has been multiplied by 1.3 and reported in Table 57. This adjustment accounts for the extra inspections of failed vehicles that a 30 percent stringency rate will generate.

TABLE 57. ANNUAL NUMBER OF INSPECTIONS REQUIRED BY URBANIZED AREA FOR 1987, ALTERNATIVE 5, CONTRACTOR RUN PORTION

Urbanized area County	Number of inspections
Indianapolis	
Marion	887,592
Hamilton	32,544
Johnson	40,990
Louisville	
Clark	62,310
Floyd	45,878
South Bend	
St. Joseph	216,455
Elkhart	76,008
Fort Wayne	
Allen	303,544
Gary-Hammond	
Lake	553.979
Porter	69,568
Total	2,288,868

Note: GCA calculations, 1978

Lane Requirements

Based on the distribution of urbanized area inspections in Table 57 and the constraints on facility size (2 to 6 lanes) presented in Section 2, the contractor network for alternative 5 appears in Table 58.

TABLE 58. REQUIREMENTS FOR ALTERNATIVE 5 - INSPECTION NETWORK

Location		Contractor approach in urbanized areas	
Urbanized area	Municipality	Facilities	Number of Lanes
Indianapolis	Indianapolis	2	12
	Nora	1	6
	South Port	1	6
Louisville	Clarksville	1	2
	New Albany	1	2
South Bend	South Bend	1	6
	Elkhart	1	2
Ft. Wayne	Ft. Wayne	2	8
Gary	Gary	1	6
	Hammond	1	6
	E. Chicago	1	2
	Portage	1	2
Total		14	60

Note: GCA calculations, 1978

CONTRACTOR NETWORK COST CONSIDERATIONS

Initial Capital Costs

These costs are the initial outlays required for real property and equipment purchases. There are three types of initial capital costs.

Land Investments--

Land investment costs are determined by network requirements, building size, building to lot ratios, access needs, local zoning regulations and similar factors. Indiana real estate sources have provided cost estimates. These costs appear in Table 59.

TABLE 59. LAND INVESTMENTS FOR EACH CONTRACTOR RUN FACILITY IN ALTERNATIVE 5

Urbanized area	Municipality	Required facilities	Number of Lanes	Lot size per facility (ft^2)	Land cost per ft^2 ($)	Cost per facility ($)	Total cost ($)	Total queue area (ft^2)	Total parking area	Total paved area	Paving cost per ft^2 ($)	Total paving cost ($)	Landscaped area	Landscape cost per ft^2 ($)	Total Landscaping cost ($)	Total improvements ($)	Total land investment ($)
Indianapolis	Indianapolis	2	12	139,980	2.00	279,960	559,920	60,000	19,440	79,440	0.80	63,552	144,530	0.25	36,133	99,685	659,605
	Mora	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	South Port	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
Louisville	Clarksville	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
	New Albany	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
South Bend	South Bend	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Elkhart	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
Ft. Wayne	Ft. Wayne	2	8	90,975	2.00	181,950	363,900	40,000	12,960	52,960	0.80	42,368	92,600	0.25	23,150	65,518	429,418
Gary	Gary	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Hammond	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	E. Chicago	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
	Portage	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
Total		14	60				2,807,370					317,760			181,438	499,198	3,306,568

Note: GCA calculations, 1978

Building Investments--

Building requirements are a function of lane area requirements (Table 3) that are based on throughput requirements. In addition to lane area, ancillary service areas and administrative space are needed as described in Section 2. Building area as a function of the number of lanes per facility are reported in Table 60. These figures include space to install safety inspection capabilities in the future.

TABLE 60. BUILDING FLOOR AREA FOR VARIOUS FACILITY CONFIGURATIONS - ALTERNATIVE 5

Configuration	Floor area required (ft^2)						
	Test area	Administration	Employee rest	Storage	Waiting	Restrooms	Total
1-lane	3,200	1,000	300	350	960	85	5,895
2-lane	6,400	1,000	350	400	1,440	85	9,675
3-lane	9,600	1,000	410	450	2,240	85	13,785
4-lane	12,800	1,000	450	500	3,360	85	18,195
5-lane	16,000	1,000	500	550	4,800	85	22,935
6-lane	19,200	1,000	550	600	6,560	85	27,995

Note: GCA calculations, 1978

Based on facility space requirements (Table 60) and alternative 6 network requirements (Table 58), building costs have been derived and they are reported in Table 61.

Equipment Costs--

Unit costs and remarks concerning major equipment items appear in Table 62.

Equipment costs as a function of facility configuration appear in Table 63. Applying these figures to the contractor network requirements for alternative 6 results in total equipment costs which are reported in Table 64.

One-time Startup Costs

This cost category consists of monies spent for noncapital items and services on a one-time basis prior to the actual program startup.

Land Acquisition--

This cost is assumed to be $6,000 per site plus 10 percent of the purchase price to cover title searches, transfer costs and so forth. Based on 14 facilities with land purchase prices totalling $2,807,370, total land acquisition costs for alternative 6 are:

TABLE 61. BUILDING COSTS FOR ALTERNATIVE 5

Urbanized area	Municipality	Facilities	Number of lanes	Building size/facility	Construction cost/sq ft	Cost per facility	Total cost
Indianapolis	Indianapolis	2	12	27,995	$30.00	$839,850	$1,679,700
	Nora	1	6	27,995	30.00	839,850	839,850
	South Port	1	6	27,995	30.00	839,850	839,850
Louisville	Clarksville	1	2	9,675	30.00	290,250	290,250
	New Albany	1	2	9,675	30.00	290,250	290,250
South Bend	South Bend	1	6	27,995	30.00	839,850	839,850
	Elkhart	1	2	9,675	30.00	290,250	290,250
Ft. Wayne	Ft. Wayne	2	8	18,195	30.00	545,850	1,091,700
Gary	Gary	1	6	27,995	30.00	839,850	839,850
	Hammond	1	6	27,995	30.00	839,850	839,850
	E. Chicago	1	2	9,675	30.00	290,250	290,250
	Portage	1	2	9,675	30.00	290,250	290,250
Total		14	60		$30.00		$8,421,900

Note: GCA calculations, 1978

TABLE 62. MAJOR EQUIPMENT ITEMS REQUIRED FOR ALTERNATIVE 5

Item	Remarks	Unit cost ($)
1. Emission analyzer	Analyzer should be capable of measuring CO and HC. Extremely wide range in analyzer costs; cheaper analyzers found to be inadequate. Analyzers should be capable of being tied into computer data handling systems. Costs based on discussions with manufacturers. (Olson-Horiba, Hamilton Test Systems)*	21,500
2. CRT terminals	Two required per lane. Costs based on literature and discussions with manufacturers' representatives (Honeywell, Digital, Olivetti, Sperry Univac) and experiences of other states	2,500
3. Mini-computer	One required per facility. Included in facility furnishings cost	80,000
4. Miscellaneous tools	As required	1,000

*Emission analyzers costed for centralized lanes differ from garage analyzers costed at $3,000 as follows: (1) to decrease purge time to a level acceptable for a high volume application, the analyzer has refrigerated bath and filtration capabilities not available in a garage analyzer; (2) to eliminate CO_2 and H_2O interference, the centralized lane analyzer has dual detector capabilities; (3) to allow computer tie-in, the analyzer is capable of linearized output; (4) to correct for high and variable ambient concentrations of HC and CO, "flowing reference cells" are included.

Note: GCA calculations, 1978.

TABLE 63. EQUIPMENT COSTS AS A FUNCTION OF FACILITY CONFIGURATION

Number of lanes	Equipment cost
1	107,500
2	135,000
3	162,500
4	190,000
5	217,500
6	245,000

TABLE 64. EQUIPMENT COSTS FOR ALTERNATIVE 5

Urbanized area	Municipality	Facilities	Number of lanes	Cost per facility	Total cost
Indianapolis	Indianapolis	2	12	$245,000	$ 490,000
	Nora	1	6	245,000	245,000
	South Port	1	6	245,000	245,000
Louisville	Clarksville	1	2	135,000	135,000
	New Albany	1	2	135,000	135,000
South Bend	South Bend	1	6	245,000	245,000
	Elkhart	1	2	135,000	135,000
Ft. Wayne	Ft. Wayne	2	8	190,000	380,000
Gary	Gary	1	6	245,000	245,000
	Hammond	1	6	245,000	245,000
	E. Chicago	1	2	135,000	135,000
	Portage	1	2	135,000	135,000
		14	60		$2,770,000
Central computer					250,000
Maintenance/calibration vans					84,000
Security systems					15,400
Total Equipment Costs					$3,119,400

Note: GCA calculations, 1978

Land acquisition cost = (14 facilities)($6000 per facility) + (0.10)($2,807,370)

= $84,000 + 280,737

= $364,737

Facilities Planning--

A facility planning cost of $842,190 is assumed. This figure is 10 percent of total building costs.

Program Design--

Based on both an analysis of the likely requirements specific to Indiana, and the experience of other states, a cost of $100,000 was arrived at for the program design estimate.

Data Handling Software--

Based on discussions with computer system analysts, an estimate of $200,000 was developed for the data handling software needed.

Personnel Training

Applying staffing rates previously discussed, the basic operating personnel requirements for alternative 5 are:

- 14 managers
- 14 assistant managers
- 180 inspectors
- 6 maintenance/calibration personnel.

The training cost per individual, as discussed in Section 2, is $53, $43, and $16 for instructors, investigators and inspectors, respectively. Applying the same assumptions as previously discussed, the startup cost of inspector training can be computed as:

(14 managers)($53) + (14 assistant managers)($16) + (180 inspectors)($16)
+ (6 maintenance/calibration persons)($16) = $3,942.00

Personnel Salaries--

Personnel costs are based on the following assumptions:

- all managerial personnel will be phased into the program 6 months prior to startup
- inspectors will be phased in 1 month prior to startup
- wage scales are:*

---

*State of Indiana Classification Plan and Salary Schedule, July 1977

managers	$15,000 per year or $1,250 per month
assistant managers	$13,000 per year or $1,083 per month
maintenance/calibration personnel	$12,000 per year or $1,000 per month
inspectors	$10,000 per year or $ 833 per month

- personnel overhead is assumed to be 25 percent of wage cost.

The total cost for test personnel wages can be computed for alternative 6 based on these assumptions. Test personnel costs are:

$$\begin{aligned}\text{Test Personnel Cost} = &\Big[(14 \text{ managers})(1{,}250)(6 \text{ months}) + \\ &(14 \text{ asst. managers})(1{,}083)(6 \text{ months}) + \\ &(6 \text{ maintenance/calibration personnel})(1{,}000/\text{month})(1 \text{ month}) \\ &+ (180 \text{ inspectors})(833/\text{month})(1 \text{ month})\Big] \; 1.25 \\ = &\ \$439{,}890\end{aligned}$$

Administrative personnel costs must also be included in the startup phase. They would be phased in beginning 18 months before program startup. Total administrative personnel costs are $1,109,813 for alternative 6. These costs are reported in Table 65. Total personnel startup costs are thus $1,549,703.

Public Information Program--

The cost estimate for this element was based on experience of various states and contractors currently involved in operating I/M programs. The basic assumption is that a budget for initial public information should be $0.12 per vehicle to be inspected or, for alternative 5, $274,664.

Annual Operating Costs

All costs associated with actual program operations fall in this category. Administrative programs like ongoing public information and inspector/mechanic training programs are not included here.

Facility Personnel--

Based on facility staffing requirements and annual salary figures for the various job categories, annual personnel costs can be computed. This estimate appears in Table 66.

Maintenance--

Primary costs for maintenance reflect equipment repair and preventive maintenance. In this connection, the yearly cost of these items was estimated to be 20 percent of the original cost. Specifically, this would be:

$$\$2{,}770{,}000 \times 0.20 = \$554{,}000$$

TABLE 65. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP - ALTERNATIVE 5

Job title	Number of positions	Annual salary per position	Total 18-month salaries for all positions
Administrator	1	$25,000	$ 37,500
Assistant Administrator (support)	1	17,000	25,500
Assistant Administrator (operations)	1	21,000	31,500
Legal Counsel	1	15,000	22,500
Purchasing Officer	1	13,000	19,500
Contracts Officer	1	13,000	19,500
Accountant	1	12,000	18,000
Engineer	1	10,400	15,600
Systems Analyst	1	11,000	16,500
Statistican/Programmer	1	10,500	15,750
Mechanic Training Coordinator	1	13,000	19,500
Regional Manager	6	21,500	193,500
Regional Inspector (licensing)	6	15,500	139,500
Regional Manager (surveillance)	6	15,500	139,500
Regional Public Information Coordinator	6	15,500	139,500
Mechanic Training Instructor	1	11,000	16,500
Instrument Repair Technician	1	12,000	18,000
Total salaries for 18 months			$ 887,850
Overhead @ 25 percent of salary			221,963
Total Administrative personnel costs			$1,109,813

Note: GCA calculations, 1978

TABLE 66. ANNUAL SALARY EXPENSE FOR FACILITY PERSONNEL

Job title	Total number of positions	Annual salary	Total annual salary for all positions
Manager	14	$15,000	$ 210,000
Assistant Manager	14	13,000	182,000
Maintenance/Calibration	6	12,000	72,000
Inspectors	180	10,000	1,800,000
Total salaries			$2,264,000
Overhead @ 25 percent			566,000
Total annual salary expense			$2,830,000

Note: GCA calculations, 1978

Calibration Costs--

The recurring annual cost of equipment calibration consists of calibration gas expenses plus the operating costs of calibration/maintenance vans. Table 67 breaks down this expense into its components.

TABLE 67. ANNUAL CALIBRATION COSTS FOR ALTERNATIVE 6

Item	Cost ($)
Gases (20 sets per year @ $200 per set)	4,000
Maintenance on van	2,800
Insurance on van and equipment	1,000
Fuel, oil, etc.	1,000
Per calibration van	8,800
Vans	6
Annually	52,800

Note: GCA calculations, 1978

Utilities/Supplies/Services--

Utilities--The annual costs for utilities were derived from electric usages experienced by other states. For alternative 5, these were found to be: 120 kWh/day for each lane, plus 325 kWh/day per facility. Per kilowatt costs were obtained from Indianapolis Power and Light, and were found to be $0.04/kWh on average. The annual cost, thus, is calculated below:

(60 lanes)(120 kWh/day-lane)($0.04/kWh)(250 operating day/yr)

+ (14 facilities)(328 kWh/day-facility)($0.04/kWh)(250 operating day/yr)

$72,000 + $45,500 = $117,500

Insurance--It is assumed that the contractor-run operation would cover fire and theft as well as liability insurance. Based on previous experience (Arizona, HTS), insurance costs generally run about $1,500/lane. Annual costs based on this estimate are calculated below:

(60 lanes)(1,500/lane) = $90,000

Computer Operation--Central computer operation costs for automated inspection systems have been estimated at $0.15 per test. This would compute to an annual cost of $343,330 for alternative 5.

Inspection Forms - In addition to the computer operation costs, a cost of $0.03 per test has been estimated based on previous experience (Arizona). This computes to a total annual cost of $68,666 for alternative 5.

Taxes--The tax cost for the contractor network for alternative 5 is calculated based on property tax rates obtained from the Indiana Board of Tax Commissioners. Tax costs are summarized in Table 68.

Uniforms--Uniforms cost $125.00 per year, based on previous experience (Arizona). For alternative 5, this amounts to $26,750 annually for 214 uniformed employees.

Security Systems--Based on experiences of other states, the annual cost of upkeep and service of security systems is $850 per facility. For alternative 5, an annual cost of $11,900 is estimated.

The costs for the utilities/supplies/services category of annual operating costs are summarized in Table 69.

Annual Administrative Costs

Program Administration--

Annual administrative personnel costs are computed from the personnel requirements and salaries delineated previously. The annual cost computation is shown in Table 70.

Public Information--

The annual cost of a public information program is estimated to be $0.12 per test as previously discussed. For this alternative, this amounts to $274,644 annually.

Personnel Training--

This element reflects the ongoing requirement to train inspectors. The replacement rate (new inspectors to be trained annually) was estimated to be 10 percent of the inspector force, based on the experience of the Arizona program. The inspector force for this alternative is 180, which relates to an annual training rate of 18 new inspectors. The cost for each individual trained, derived previously, is $16.00, therefore the entire annual cost is $288.00.

Total Alternative Costs--

The total cost of the contractor-run portion of alternative 5 is summarized in Table 71. Capital costs are $14,847,868, one-time startup costs are $3,335,236, and ongoing annual operating and administrative expenses are $4,280,629 and $1,014,827, respectively.

TABLE 68. TAXES FOR ALTERNATIVE 5[*]

Urbanized area	Municipality	Facility	Number of lanes	Taxable property	Rate (%)	Tax ($)
Indianapolis	Indianapolis	2	12	2,829,304	1.2694	$ 35,915
	Nora	1	6	1,414,652	1.2694	17,958
	South Port	1	6	1,414,652	0.9927	14,043
Louisville	Clarksville	1	2	538,957	0.9850[†]	5,309
	New Albany	1	2	538,957	0.6350	3,422
South Bend	South Bend	1	6	1,414,652	1.2530	17,726
	Elkhart	1	2	538,957	0.9801	5,283
Ft. Wayne	Ft. Wayne	2	8	1,901,118	1.0698	23,627
Gary	Gary	1	6	1,414,652	1.7442	24,674
	Hammond	1	6	1,414,652	1.8017	25,488
	E. Chicago	1	2	538,957	1.2366	6,665
	Portage	1	2	538,957	1.0340	5,573
Total				14,498,467		185,683

[*] Tax rates obtained from the Indiana Board of Tax Commissioners

[†] No figure available. County average used.

Note: GCA calculations, 1978

TABLE 69. ANNUAL COST FOR UTILITIES, SERVICES, AND SUPPLIES

Utilities	$117,500
Insurance	90,000
Computer operation	343,330
Inspection forms	68,666
Calibration costs	52,800
Taxes	185,683
Uniforms	26,750
Security Systems	11,900
Total	$896,629

Note: GCA calculations, 1978

TABLE 70. ANNUAL ADMINISTRATIVE PERSONNEL COSTS - ALTERNATIVE 5

Job title	Number of positions	Annual salary per position ($)	Total annual salaries for all positions ($)
Administrator	1	25,000	25,000
Assistant Administrator (Support)	1	17,000	17,000
Assistant Administrator (Operations)	1	21,000	21,000
Legal Counsel	1	15,000	15,000
Purchasing Officer	1	13,000	13,000
Contractor Officer	1	13,000	13,000
Accountant	1	12,000	12,000
Engineer	1	10,400	10,400
Systems Analyst	1	11,000	11,000
Statistician/Programmer	1	10,500	10,500
Mechanic Training Coordinator	1	13,000	13,000
Regional Manager	6	21,500	129,000
Regional Inspector (Licensing)	6	15,500	93,000
Regional Manager (Surveillance)	6	15,500	93,000
Regional Public Information Coordinator	6	15,500	93,000
Mechanic Training Instructor	1	11,000	11,000
Instrument Repair Technician	1	12,000	12,000
Total Salaries			591,900
Overhead @ 25 percent			147,975
Total Annual Administrative Costs			739,875

Note: GCA calculations, 1978

TABLE 71. CONTRACTOR NETWORK COST SUMMARY, ALTERNATIVE 5

Cost category		Cost element	Amount	Category total
I.	Capital Costs	1. Land investment	$3,306,568	
		2. Building investment	8,421,900	
		3. Equipment cost	2,770,000	
		4. Central computer	250,000	
		5. Maintenance vans	84,000	
		6. Security systems	15,400	
				$14,847,868
II.	One-time Start-up Costs	1. Land acquisition	$ 364,737	
		2. Facilities planning	842,190	
		3. Program design	100,000	
		4. Data software	200,000	
		5. Personnel training	3,942	
		6. Personnel salaries, overhead	1,549,703	
		7. Initial public relations	274,664	
				$ 3,335,236
III.	Annual Operating Costs	1. Facility personnel	$2,830,000	
		2. Maintenance	554,000	
		3. Utilities/Services/ Supplies	896,629	
				$ 4,280,629
IV.	Annual Administrative Costs	1. Administrative personnel	$ 739,875	
		2. Annual public relations	274,664	
		3. Personnel training	288	
				$1,014,827

Note: GCA calculations, 1978

FEE COMPUTATION

The cost of an emissions inspection to motorists in the seven nonattainment counties is given by the following formula:

$$\text{Inspection fee} = \frac{\text{Total annual costs}}{\text{Total inspections required}}$$

The capital costs and startup costs presented in the previous tables are converted to annual figures by use of the amortization factors described in Section 2. Annual operating and administrative costs are then added to the annualized capital and startup costs to obtain total annual costs in real (constant) 1978 dollars. The fee, f_c, is derived by dividing the total annual costs by the annual number of paid inspections. This fee is in 1978 dollars, and thus must be increased over time to compensate for inflation. It is calculated in Table 72.

The above fees were calculated on the assumptions that retests of failed vehicles cost the same amount as initial inspections of these vehicles. If it is decided that retests should be free, the fee would be 1.3 times the above fees, since there is a 30 percent stringency factor. Table 73 presents contractor fees for alternative 6 for both paid and free retests.

DETERMINATION OF CERTIFIED STATE INSPECTION STATION NETWORK

Alternative 5 proposes adding idle mode emissions testing to the existing safety inspection in those parts of the seven nonattainment counties not included in the five urbanized areas served by contractor run facilities. In the remainder of Indiana, the existing certified state inspection station (CSIS) network will continue to perform only safety inspections.

Thus, alternative 5 establishes emissions inspections in the seven nonattainment counties and those parts of five urbanized areas that are outside the nonattainment counties (see Figure 3).

Relevant Vehicle Population

Certified state inspection stations in the rural portions of the seven nonattainment counties will implement I/M idle mode testing under this alternative. The vehicle population for these areas has been projected forward to 1987 using the methodology explained in Section 2. The vehicle population is multiplied by 0.96 to exclude those vehicles exempt from I/M, and then multiplied by 1.3 to arrive at the total number of inspections that must be performed in 1987, assuming a 30 percent stringency rate. Table 74 lists the relevant vehicle population and the number of inspections associated with it for 1987.

TABLE 72. CONTRACTOR FEE COMPUTATION, ALTERNATIVE 5, 1987

	(when i=0.03)	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital Costs			
	1. Land	3,306,568	0.03	99,197
	2. Buildings	8,421,900	0.067	564,267
	3. Equipment	3,119,400	0.2184	681,277
II.	Startup Costs	3,335,236	0.2184	728,416
III.	Operating Costs	4,280,629	1.0	4,280,629
IV.	Administrative Costs	1,014,827	1.0	1,014,827
	Total			7,368,613
$f_{c_{0.03}}$	cost per inspection	= 7,368,613	/2,288,868	= 3.219

	(when i=0.06)	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital Costs			
	1. Land	3,306,568	0.06	198,394
	2. Buildings	8,421,900	0.087	732,705
	3. Equipment	3,119,400	0.2374	740,546
II.	Startup Costs	3,335,236	0.2374	791,785
III.	Operating Costs	4,280,629	1.0	4,280,629
IV.	Administrative Costs	1,014,827	1.0	1,014,827
	Total			7,758,886
$f_{c_{0.06}}$	cost per inspection	= 7,758,886	/2,288,868	= 3.390

Note: GCA calculations, 1978

TABLE 73. CONTRACTOR FEES, ALTERNATIVE 5 (CONSTANT 1978 DOLLARS)

	i=0.03	i=0.06
Free retests	4.185	4.407
Paid retests	3.219	3.390

TABLE 74. RELEVANT VEHICLE POPULATION AND NUMBER OF INSPECTIONS REQUIRED, CERTIFIED STATE INSPECTION STATION NETWORK, ALTERNATIVE 5, 1987

County	Rural vehicle population	Rural inspections required
Allen	54,242	67,694
Clark	38,636	48,218
Floyd	17,163	21,419
Lake	32,487	40,544
Marion	0	0
Porter	60,362	75,332
St. Joseph	31,654	39,504
Total	234,544	292,711

Note: GCA calculations, 1978

DISTRIBUTION OF THE CERTIFIED STATE INSPECTION STATION NETWORK

For program administrative purposes, Indiana will be divided in the following analysis into six regions (see Figure 5). Table 75 presents the CSIS network for alternative 5 and distributes the counties in question into their respective administrative regions. The 1987 network is assumed to be 90 percent of the present network. The 10 percent dropout figure is due to the higher capital costs associated with emissions inspections. Using this assumption, the CSIS network for the rural portions of the seven nonattainment counties will contain 136 stations.

TABLE 75. CSIS NETWORK FOR THE RURAL PORTIONS OF SEVEN NONATTAINMENT COUNTIES IN 1987

Region County	Number of certified state inspection stations
Northwest Indiana	
Lake	39
Porter	36
North Central Indiana	
St. Joseph	18
Northeast Indiana	
Allen	22
Central Indiana	
Marion	0
Southeast Indiana	
Clark	16
Floyd	5
Southwest Indiana	-
Total	136

Note: GCA calculations, 1978

Requirements for Quality Control

It is especially important that an effective system for guaranteeing a high level of quality control over the CSIS network be maintained. A CSIS network implies a number of HC/CO analyzers that must be accurately calibrated and checked frequently; U.S. EPA regulations require monthly calibrations. For this purpose the agency overseeing the I/M program should maintain a fleet of inspection and licensing vans (ILV).

These vehicles will be equipped to check the accuracy of HC/CO analyzers in use at certified state inspection stations. Based on monthly inspections, it is assumed that one inspection and licensing van is needed to properly oversee 70 certified state inspection stations. ILV requirements include an additional 15 percent over this figure to account for breakdowns, scheduled maintenance, etc.

Complaints investigation vehicles are also needed. Approximately one such vehicle per 100 CSIS locations should be sufficient; a 15 percent reserve cushion is also assumed. The inspection and licensing van and complaints investigation vehicle requirements are broken down by region and presented in Table 76.

TABLE 76. QUALITY CONTROL VEHICLE REQUIREMENTS, ALTERNATIVE 5

Region	Number of CSIS	Number of I&L vans	Number of complaints vehicles
Northwest Indiana			
Lake County	39	2	2
Porter County	36		
North Central Indiana			
St. Joseph County	18	1	1
Northeast Indiana			
Allen County	22	1	1
Central Indiana			
Marion County	0	0	0
Southeast Indiana			
Clark County	16	1	1
Floyd County	5		
Total	136	5	5

Note: GCA calculations, 1978

It should be noted that CSIS networks in several regions are so small that one of each type of quality assurance vehicle is more than sufficient to meet the monthly inspection requirements.

FEE CALCULATIONS FOR THE CERTIFIED STATE INSPECTION STATION NETWORK

CSIS Inspection Fee Computation

Fee calculations have been made based on both free and paid reinspections. As derived in Section 2, the following formula determines the fee a CSIS will charge:

$$N(P - F) = A + (L + \emptyset) NT + X + M + G$$

where:

N = paid inspections performed at a CSIS in 1 year

P = price charged by a CSIS for an inspection

F = administrative "sticker" fee paid to the state by a CSIS for each safety inspection

A = annualized cost of owning an HC/CO analyzer, assumed to be $655

L = hourly labor cost, assumed to be $7.33 including labor overhead

$\emptyset$ = overhead cost for the bay used to perform the CSIS inspection, assumed to be $8.67 per hour

T = length of time needed to perform an inspection. An emissions only test is assumed to take 5 minutes, a safety inspection is 15 minutes long, and a combined test lasts 20 minutes

X = the annual licensing fee paid by the station to the state, here assumed to be $40.00

M = maintenance cost for an HC/CO analyzer, assumed to be 20 percent of purchase price or $600 per year

G = cost of calibration gas for HC/CO analyzer. Assumed to be $200 per year.

The critical variable in the above equation is the annual vehicle throughput (N). As will be shown below, there is a considerable variation in (N) across the different areas serviced by the CSIS emissions inspection network for alternative 5. Table 77 shows the average annual throughput for CSIS's in each area in question.

If a 250-day work year is assumed, the above annual throughputs can be broken down into average daily throughputs, which range from 4.2 inspections per day, or under 1½ hours per day spent on inspections for Lake County, to 17.1 inspections per day, or almost 6 hours per day spent on inspections in Floyd County.

Substituting the annual throughputs calculated above into the fee equation, CSIS inspection fees, assuming paid retests of failed vehicles, can be calculated for each of the six counties in question. Fees are shown in Table 78. With free emissions retests, the cost of the emission test increases by 1.3. The total costs (safety and emissions) range from $6.18 in Floyd County to $7.27 in Lake County with a paid emissions retest, and from $6.69 in Floyd County to $8.10 in Lake County with a free emissions retest.

TABLE 77. AVERAGE ANNUAL THROUGHPUT, CSIS EMISSIONS INSPECTION NETWORK, ALTERNATIVE 5

Region		Average annual throughput, (N) (vehicles inspected)
Northwest Indiana		
Lake County	(rural portion)	1,040
Porter County	(rural portion)	2,093
North Central Indiana		
St. Joseph County	(rural portion)	2,195
Northeast Indiana		
Allen County	(rural portion)	3,077
Southeast Indiana		
Clark County	(rural portion)	3,014
Floyd County	(rural portion)	4,284
Central Indiana		
No coverage		-
Southwest Indiana		
No coverage		-

Note: GCA calculations, 1978

TABLE 78. CSIS INSPECTION FEES, ALTERNATIVE 5, 1987 (CONSTANT 1978 DOLLARS)

Region		Safety*	Emissions with paid retest	Emissions with free retest	Total cost* with paid emissions retests	Total cost* with free emissions retests
Northwest Indiana						
Lake County	(rural portion)	$4.50	2.771	3.602	7.271	8.102
Porter County	(rural portion)	$4.50	2.048	2.662	6.548	7.162
North Central Indiana						
St. Joseph County	(rural portion)	$4.50	2.014	2.618	6.514	7.118
Northeast Indiana						
Allen County	(rural portion)	$4.50	1.819	2.365	6.319	6.865
Southeast Indiana						
Clark County	(rural portion)	$4.50	1.829	2.378	6.329	6.878
Floyd County	(rural portion)	$4.50	1.682	2.187	6.182	6.687
Central Indiana						
No coverage			-	-	-	-
Southwest Indiana						
No coverage			-	-	-	-
Average		$4.50	2.028	2.636	6.528	7.136

*Safety inspection includes free retest policy. Costs are $4.00 for the CSIS plus $0.50 for the safety sticker.

Note: GCA calculations, 1978

State Emissions Sticker Fee Computation

It should be emphasized that these figures do not represent the entire fee each motorist will pay. In addition to the cost of performing inspections, the fee collected must include the "sticker" fee (F), levied by the state to cover program costs in the rural portions of urban counties. These costs include the purchase price of quality control vehicles, operating personnel, training costs, salaries, etc. No administrative costs nor public information costs are included. It is assumed that no additional state- or regional-level administrative personnel will be required to oversee CSIS operations beyond the admin-istrative personnel and costs included in the $4.50 safety inspection fee. More careful scrutiny will be required in the next phase. The emissions sticker fee is calculated in Table 79.

By adding the state sticker fee, F, to the CSIS inspection costs calculated previously, the total charge, P, for an inspection in the rural portions of the seven urbanized counties is obtained. This total charge is presented in Table 80.

Public Information Program

Both the initial and the ongoing cost for a public information program for the certified state inspection station network coverage of alternative 5 is assumed to be higher than the cost necessary for the contractor-operated portion of this alternative. This is due to the fact that this aspect of this alternative is thought to be especially difficult to present to the public. Due to the geographic coverage specifications (three different coverage areas), the degree of public education necessary for this alternative is higher than in previous alternatives.

A more extensive public relations campaign for alternative 5 is therefore assumed to entail a cost of $0.25 per vehicle tested. This represents a total cost of $58,636 for the vehicle population mentioned (234,544 vehicles) which will be inspected in this CSIS network. This cost has not been added to other cost computations, as it varies considerably depending on the campaign design.

A more specific cost estimate for public relations may be added to other program costs in the future as the public relations program aspects become more concrete. The public relations campaign for emissions testing in the CSIS network may also be coordinated jointly with the existing program used for safety inspections in the future years of an I/M regime.

POSSIBLE EXTERNALITIES AND LEGISLATIVE CONSIDERATIONS

This section deals with issues that specifically affect alternative 5. While no particular legal problems were found that could affect this alternative at either the state or federal level, there are practical and political considerations worth noting.

Emissions inspection in alternative 5 will be provided in the seven nonattainment counties and those parts of the "urbanized area" designations that extend beyond the nonattainment areas into portions of Elkhart, Hamilton and Johnson Counties.

TABLE 79. STATE STICKER FEE CALCULATIONS, ALTERNATIVE 5

When i=0.03	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital costs			
1. 5 inspection and licensing vehicles	44,000	0.2184	9,610
2. 5 complaints vehicles	25,000	0.2184	5,460
II. One-time startup costs			
1. Personnel training	430	0.2184	94
2. Personnel salaries and overhead	257,813	0.2184	56,306
III. Annual operating costs			
1. Maintenance	13,800	1.0	13,800
2. Calibration	44,000	1.0	44,000
3. Personnel salaries and overhead	171,875	1.0	171,875
Total			301,145
State sticker fee 0.03	$= \frac{\$301,145}{292,711} = \$1.029$		

Note: GCA calculations, 1978

TABLE 79 (continued). STATE STICKER FEE CALCULATIONS, ALTERNATIVE 5

When i=0.06	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital costs			
1. 5 inspection and licensing vehicles	44,000	0.2374	10,446
2. 5 complaints vehicles	25,000	0.2374	5,935
II. One-time startup costs			
1. Personnel training	430	0.2374	102
2. Personnel salaries and overhead	257,813	0.2374	61,205
III. Annual operating costs			
1. Maintenance	13,800	1.0	13,800
2. Calibration	44,000	1.0	44,000
3. Personnel salaries and overhead	171,875	1.0	171,875
Total			307,363
State sticker fee 0.06	$= \frac{\$307,363}{292,711} = \$1.050$		

Note: GCA calculations, 1978

TABLE 80. TOTAL INSPECTION CHARGE (P), CSIS NETWORK IN RURAL PORTIONS OF URBANIZED COUNTIES, ALTERNATIVE 5, 1987 (CONSTANT 1978 DOLLARS) (i=0.06)

Region	Paid retests	Free retests
Northwest Indiana		
Lake County	8.321	9.468
Porter County	5.798	8.527
North Central Indiana		
St. Joseph County	7.564	8.483
Northeast Indiana		
Allen County	7.369	8.230
Southeast Indiana		
Clark County	7.379	8.243
Floyd County	7.237	8.052
Central Indiana		
No coverage	-	-
Southwest Indiana		
No coverage	-	-
Average	7.578	8.501

Note: GCA calculations, 1978

The five urbanized areas, established by metropolitan planning organizations for regional planning purposes, are used in defining geographic scope of alternate 5 emissions inspection. Within these urbanized areas a contractor-operated network will perform emissions testing only. The urbanized CSIS network will continue to perform existing safety inspections. Motorists residing within the five urbanized areas must therefore travel to a contractor-operated facility to undergo an emissions inspection and then proceed to a CSIS for a safety inspection. The "two-stop" nature of program coverage within the urbanized areas may generate adverse public reaction. Such resistance is more likely to occur if the citizens of Indiana are aware of inspection programs elsewhere which combine both types of inspection in one facility.

In the rural portions of the seven nonattainment counties, a combined emissions and safety inspection will be administered by the CSIS network. As shown in Table 81, the inspection stations in these areas may experience difficulties in meeting the inspection demands placed upon them by the urbanized-rural coverage of alternative 5. At present, certified state inspection stations are concentrated in urban areas, and rather sparsely scattered across rural areas. As a result, the per station throughputs in the rural portions of Allen, Clark, and Floyd counties will be so great that over 4 hours per station per day will have to be devoted to inspection activities. If these stations are already operating at or near capacity, these additional demands may significantly overburden the network. This problem is particularly severe in Floyd County where five stations must spend nearly 6 hours per day on inspection work.

Establishing an I/M program along these urbanized area boundary lines requires dividing nine counties along rural-urban lines. It will not be easy to determine which vehicles in these counties are registered in rural areas and which are registered in urban areas. Postal addresses are not appropriate for this purpose because some households have postal addresses that do not correspond with their actual places of residence. Also, some forms of address (e.g., route numbers) are not specific enough to locate them inside or outside of the urbanized areas.

In general, the public recognizes and understands boundaries, such as county lines and city limits, that are used for administrative purposes. They are less familiar with regional planning boundaries such as the urbanized area lines around which alternative 5 is designed. Since they are unfamiliar to most citizens, a major public information program will be required to familiarize the public with these designations. The public information problem may be further complicated because the metropolitan planning organizations periodically redefine their "urbanized areas."

Also, since urbanized areas are not presently used for administrative purposes, the state cannot easily tie motor vehicle registrations, enforcement efforts, etc., into existing administrative procedures. A new system will have to be devised to determine which vehicles are registered within the urbanized areas and which are not. Establishing changes such as these is liable to be quite costly.

TABLE 81. AVERAGE HOURS PER DAY DEVOTED TO INSPECTION ACTIVITIES, CSIS EMISSIONS INSPECTION NETWORK, ALTERNATIVE 5

Region	Average hours per day devoted to inspection activities
Northwest Indiana	
Lake County (rural portion)	1.39
Porter County (rural portion)	2.79
North Central Indiana	
St. Joseph County (rural portion)	2.93
Northeast Indiana	
Allen County (rural portion)	4.10
Southeast Indiana	
Clark County (rural portion)	4.02
Floyd County (rural portion)	5.71
Central Indiana	
no coverage	-
Southwest Indiana	
no coverage	-

EMISSION REDUCTION BENEFITS

Inspection/Maintenance is designed to improve ambient air quality by lowering vehicular emissions levels. The magnitude of potential emissions reductions is dependent on the size of the vehicle population covered by a mandatory program. Emission reductions for 1987 that would result from implementing I/M were calculated using the Environmental Protection Agency's Mobile I computer routine.

The results of these calculations appear in Tables 82 and 83. Statewide vehicle HC reductions will be 7.4 percent of 1987 non-I/M levels if the program is implemented. This figure is misleading to a certain extent. The majority of benefits will occur in the areas in which the program operates. Reductions are reported for the seven nonattainment counties. 1987 I/M HC emission levels are between 20.2 and 32.0 percent lower than 1987 non-I/M levels on a county basis. Total vehicle HC emissions will be 295,042 kg per day.

CO emissions will be 3,073,851 kg per day. This figure is 8.6 percent lower than non-I/M emission levels for the entire state. Reductions within the seven nonattainment counties vary between 23.4 and 34.7 percent lower than 1987 non-I/M emission levels.

TABLE 82. DAILY HYDROCARBON EMISSIONS FOR ALTERNATIVE 5 (kg/day)

Area	Heavy-Duty Trucks									Light-Duty Vehicles												All Vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M Auto	1987 With I/M Auto	1975 LD Truck	1982 LD Truck	1987 Without I/M LD Truck	1987 With I/M LD Truck	1975 Total	1982 Total	1987 Without I/M Total	1987 With I/M Total	1975	1982	1987 Without I/M	1987 With I/M	Percent Reduction 1977 to 1987 With I/M	Percent Reduction 1987 Without I/M to 1987 with I/M
Allen County	250	269	220	1,488	1,139	516	1,767	1,388	766	22,780	11,666	6,799	4,806	3,466	[illegible]	1,513	1,266	26,266	16,130	8,312	5,866	28,011	15,308	9,055	6,612	76.4%	27.0%
Clark County	500	738	551	305	275	165	976	1,013	696	9,606	4,095	2,888	2,060	2,788	1,697	1,217	893	12,396	5,792	4,025	2,953	13,368	7,805	4,721	3,649	72.7%	22.7%
Floyd County	251	316	257	151	108	57	402	418	314	3,759	2,122	1,330	839	1,111	822	563	397	4,870	2,944	1,893	1,336	5,272	3,362	2,207	1,650	68.7%	25.2%
Lake and Porter Counties	2,764	3,050	2,406	18,130	13,419	7,366	20,894	16,469	9,772	27,332	16,025	8,567	5,658	12,072	6,384	5,783	3,819	39,404	22,409	14,350	9,477	60,298	38,878	24,122	19,249	68.1%	20.2%
Marion County	1,490	1,786	1,371	15,119	11,505	7,396	16,609	13,299	8,765	76,286	30,637	23,306	15,930	17,069	7,825	4,790	3,285	86,353	40,462	28,186	19,215	102,962	59,941	36,969	27,986	72.8%	24.2%
St. Joseph County	281	295	221	1,720	1,134	514	2,001	1,429	735	23,527	11,169	6,124	4,176	4,299	2,462	1,608	762	27,826	13,631	7,732	4,938	29,827	15,260	8,467	5,673	81.2%	[illegible]
Remainder of State	4,656	6,094	5,156	46,837	44,360	27,308	51,203	50,454	32,464	432,312	246,486	156,228	153,915	[illegible]	65,396	[illegible]	63,050	512,630	312,082	200,536	197,565	563,932	362,619	233,198	230,229	59.2%	1.3%
Statewide	10,090	12,400	10,190	83,830	72,230	43,500	93,920	84,630	53,690	595,000	301,920	205,230	187,300	[illegible]	86,820	59,700	53,056	709,790	418,780	269,030	241,353	803,670	503,370	318,720	295,062	63.3%	7.4%

TABLE 83. DAILY CARBON MONOXIDE EMISSIONS FOR ALTERNATIVE 5 (kg/day)

Area	Heavy-Duty Trucks									Light-Duty Vehicles												All Vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M Auto	1987 With I/M Auto	1975 LD Truck	1982 LD Truck	1987 Without I/M LD Truck	1987 With I/M LD Truck	1975 Total	1982 Total	1987 Without I/M Total	1987 With I/M Total	1975	1982	1987 Without I/M	1987 With I/M	Percent Reduction 1977 to 1987 With I/M	Percent Reduction 1987 Without I/M to 1987 with I/M
Allen County	1,703	1,628	1,702	15,641	18,701	11,765	17,424	20,329	13,467	164,166	102,517	59,307	36,409	24,100	21,742	15,715	9,110	188,267	124,239	75,022	45,307	205,691	144,568	88,489	56,992	72.3%	35.6%
Clark County	4,213	4,360	4,181	4,342	4,448	3,254	8,555	8,814	7,435	72,770	45,300	26,083	16,239	18,945	17,433	12,949	8,064	91,715	62,801	39,034	24,300	100,270	71,335	46,469	31,735	68.4%	31.7%
Floyd County	1,785	1,723	1,958	1,866	1,780	1,159	3,651	3,483	3,117	29,616	20,177	12,676	7,416	7,752	7,755	6,078	3,613	37,368	27,932	18,366	11,029	40,619	31,354	21,871	14,146	65.3%	34.7%
Lake and Porter Counties	21,697	19,299	19,826	202,234	194,060	108,986	223,931	213,359	128,816	230,431	147,669	83,712	47,110	109,033	99,115	65,271	36,712	388,470	246,996	148,983	83,862	[illegible]	460,203	277,799	212,638	64.1%	23.4%
Marion County	11,609	10,481	11,137	141,135	143,827	100,098	152,744	154,318	111,235	643,383	385,336	213,619	123,638	74,024	69,440	36,867	22,085	727,697	454,976	250,486	147,686	877,361	609,294	361,721	258,861	70.5%	28.4%
St. Joseph County	2,024	1,722	1,753	18,468	19,461	11,637	20,492	21,183	13,390	179,815	102,144	51,313	30,316	30,889	25,388	15,910	9,038	210,704	127,730	67,223	39,348	231,208	148,913	80,563	52,688	77.2%	34.6%
Remainder of State	28,630	29,462	36,769	514,414	756,653	668,351	543,053	786,315	705,070	2,890,539	2,097,139	1,363,098	1,317,380	426,735	470,811	433,750	424,381	3,317,274	2,568,350	1,779,648	1,761,701	3,860,327	3,354,665	2,486,718	2,466,771	36.6%	1.5%
Statewide	71,750	68,190	77,200	897,960	1,138,030	905,210	969,690	1,207,440	982,380	4,241,960	2,901,150	1,792,410	1,576,120	696,370	711,990	586,370	515,080	4,938,310	3,613,060	2,378,930	2,091,353	5,908,000	4,820,480	3,361,430	3,073,031	48.0%	8.6%

Reproduced from
best available copy.

SECTION 8

ALTERNATIVE 6 -
- CONTRACTOR OPERATED IDLE-MODE EMISSIONS INSPECTION ONLY IN FIVE URBANIZED AREAS
- CERTIFIED STATE INSPECTION STATION OPERATED SAFETY INSPECTION ONLY IN FIVE URBANIZED AREAS
- CERTIFIED STATE INSPECTION STATION OPERATED COMBINED IDLE-MODE EMISSION AND SAFETY INSPECTION IN THE REMAINDER OF THE STATE

ALTERNATIVE DEFINITION

In alternative 6 it is proposed that idle-mode emissions testing and safety inspections be performed throughout Indiana. For this alternative, ownership of the emissions test facility is specified on an urbanized-rural area basis. Within the five urbanized areas (Gary, South Bend, Fort Wayne, Indianapolis, and Louisville) a contractor will operate centralized idle-mode emissions inspection facilities. In the same five urbanized areas, the existing certified state inspection station network will continue to perform safety inspections. Thus, in the five urbanized areas, at least at the outset of the program, each vehicle will be required to travel to two separate locations, one in order to be tested for emissions levels, and another in order to have a safety inspection performed. The contractor-run facilities have been designed so that safety inspection functions can, at some future date, be added to the emissions inspection without incurring additional expenses for land or buildings.

Outside the five urbanized areas, the existing certified state inspection station (CSIS) network will continue to perform safety inspection functions; this network will also be required to perform idle-mode emissions tests. Thus, alternative 6 specifies that a combined emissions and safety inspection be conducted by the existing CSIS network outside the five urbanized areas.

DETERMINATION OF THE CONTRACTOR RUN NETWORK

Relevant Vehicle Population

While alternative 6 will involve the entire state with emissions inspection coverage, the contractor-run operation is concerned only with the 1987 vehicle population within the five urbanized areas specified. Table 84 reports the 1987 vehicle population.

TABLE 84. ANNUAL NUMBER OF INSPECTIONS REQUIRED BY URBANIZED AREA FOR 1987, ALTERNATIVE 6 - CONTRACTOR COVERAGE

Urbanized area/county	Number of inspections
Indianapolis	
Marion	887,592
Hamilton	32,544
Johnson	40,990
Louisville	
Clark	62,310
Floyd	45,878
South Bend	
St. Joseph	216,455
Elkhart	76,008
Fort Wayne	
Allen	303,544
Gary-Hammond	
Lake	553,979
Porter	69,568
Total	2,288,868

Note: GCA calculations, 1978.

Lane Requirements

Based on the distribution of urbanized area inspections in Table 84 and the constraints on facility size (2 to 6 lanes) presented in Section 2, the contractor network necessary to meet inspection demand for alternative 6 appears in Table 85.

CONTRACTOR NETWORK COST CONSIDERATIONS

Initial Capital Costs

These costs are the initial outlays required for real property and equipment purchases. There are three types of initial capital costs.

Land Investments--

Land investment costs are a function of network requirements, building area, building to lot ratios, access requirements, local zoning regulations and so forth. Indiana real estate sources have provided cost estimates. Land investment costs for alternative 6 appear in Table 86.

TABLE 85. INSPECTION NETWORK REQUIREMENTS FOR ALTERNATIVE 6 - CONTRACTOR APPROACH IN URBANIZED AREAS

Location		Required facilities	Number of lanes
Urbanized area	Municipality		
Indianapolis	Indianapolis	2	12
	Nora	1	6
	South Port	1	6
Louisville	Clarkville	1	2
	New Albany	1	2
South Bend	South Bend	1	6
	Elkhart	1	2
Fort Wayne	Fort Wayne	2	8
Gary	Gary	1	6
	Hammond	1	6
	East Chicago	1	2
	Portage	1	2
Total		14	60

Note: GCA calculations, 1978.

TABLE 86. LAND INVESTMENTS FOR CONTRACTOR-RUN FACILITIES, ALTERNATIVE 6

Urbanized area	Municipality	Required facilities	Number of lanes	Lot size per facility (ft^2)	Land cost per ft^2 ($)	Cost per facility ($)	Total cost ($)	Total queue area (ft^2)	Total parking area	Total paved area	Paving cost per ft^2 ($)	Total paving cost ($)	Landscaped area	Landscape cost per ft^2 ($)	Total landscaping cost ($)	Total improvements ($)	Total land investment ($)
Indianapolis	Indianapolis	2	12	139,980	2.00	279,960	559,920	60,000	19,440	79,440	0.80	63,552	144,530	0.25	36,133	99,685	659,605
	Nora	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	South Port	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
Louisville	Clarksville	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
	New Albany	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
South Bend	South Bend	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Elkhart	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
Fort Wayne	Fort Wayne	2	8	90,975	2.00	181,950	363,900	40,000	12,960	52,960	0.80	42,368	92,600	0.25	23,150	65,518	429,418
Gary	Gary	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	Hammond	1	6	139,980	2.00	279,960	279,960	30,000	9,720	39,720	0.80	31,776	72,265	0.25	18,066	49,842	329,802
	East Chicago	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
	Portage	1	2	48,375	2.00	96,750	96,750	10,000	3,240	13,240	0.80	10,592	25,460	0.25	6,365	16,957	113,707
Total		14	60				2,807,370					317,760			181,438	499,198	3,306,568

Note: GCA calculations, 1978.

Building Investments--

Building requirements are a function of lane area requirements (Table 5) that are based on throughput requirements. In addition to lane area, ancillary service areas and administrative space are needed as described in Section 2. Table 87 summarizes building area needs as a function of the number of lanes per facility. It should be noted that these space calculations include extra space sufficient to expand to provide safety inspections along with emissions testing in the future. The network, however, has been specified in terms of the original test mode.

Based on the building cost assumptions in Section 2, facility space requirements (Table 87) and alternative 6 network requirements (Table 85), building cost estimates can be derived. They appear in Table 88.

Equipment Costs--

The cost of major equipment purchases comprises the final category of initial capital costs. Unit costs and remarks concerning these major items appear in Table 89.

Equipment costs as a function of facility configuration appear in Table 90. Applying these figures to the contractor network requirements for alternative 6 results in total equipment costs which are reported in Table 91.

One-time Startup Costs

This cost category consists of monies spent for noncapital items and services on a one-time basis prior to the actual program startup.

Land Acquisition--

Land acquisition costs are assumed to be $6,000 per site plus 10 percent of the purchase price to cover title searches, transfer expenses and so forth. Based on 14 facilities with land purchase prices totaling $2,807,370, total land acquisition costs for alternative 6 are:

land acquisition cost = (14 facilities)($6000 per facility) + (0.10)($2,807,370)
= $84,000 + $280,737
= $364,737

Facilities Planning--

Building costs for alternative 6 are $8,421,900. For building costs in excess of $6 million, facility planning costs are assumed to be 10 percent of building costs. Thus, facility planning costs are estimated at $842,190.

Program Design--

Based on both an analysis of the likely requirements specific to Indiana, and the experience of other states, a cost of $100,000 was arrived at for the program design estimate.

Data Handling Software--

Based on discussions with computer system analysts, an estimate of $200,000 was developed for data handling software needed.

TABLE 87. BUILDING FLOOR AREA FOR VARIOUS FACILITY CONFIGURATIONS - ALTERNATIVE 6

Lane configuration	Floor area required (ft^2)						
	Test area	Administration	Employee rest	Storage	Waiting	Restrooms	Total
1	3,200	1,000	300	350	960	85	5,895
2	6,400	1,000	350	400	1,440	85	9,675
3	9,600	1,000	410	450	2,240	85	13,785
4	12,800	1,000	450	500	3,360	85	18,195
5	16,000	1,000	500	550	4,800	85	22,935
6	19,200	1,000	550	600	6,560	85	27,995

Note: GCA calculations, 1978.

TABLE 88. BUILDING COSTS FOR ALTERNATIVE 6

Location		Facilities	Number of lanes	Building size per facility (ft^2)	Construction cost per ft^2 ($)	Cost per facility ($)	Total cost ($)
Urbanized area	Municipality						
Indianapolis	Indianapolis	2	12	27,995	30	839,850	1,679,700
	Nora	1	6	27,995	30	839,850	839,850
	South Port	1	6	27,995	30	839,850	839,850
Louisville	Clarksville	1	2	9,675	30	290,250	290,250
	New Albany	1	2	9,675	30	290,250	290,250
South Bend	South Bend	1	6	27,995	30	839,850	839,850
	Elkhart	1	2	9,675	30	290,250	290,250
Fort Wayne	Fort Wayne	2	8	18,195	30	545,850	1,091,700
Gary	Gary	1	6	27,995	30	839,850	839,850
	Hammond	1	6	27,995	30	839,850	839,850
	East Chicago	1	2	9,675	30	290,250	290,250
	Portage	1	2	9,675	30	290,250	290,250
Total		14	60				8,421,900

Note: GCA calculations, 1978.

TABLE 88. BUILDING COSTS FOR ALTERNATIVE 6

Location		Facilities	Number of lanes	Building size per facility (ft^2)	Construction cost per ft^2 ($)	Cost per facility ($)	Total cost ($)
Urbanized area	Municipality						
Indianapolis	Indianapolis	2	12	27,995	30	839,850	1,679,700
	Nora	1	6	27,995	30	839,850	839,850
	South Port	1	6	27,995	30	839,850	839,850
Louisville	Clarksville	1	2	9,675	30	290,250	290,250
	New Albany	1	2	9,675	30	290,250	290,250
South Bend	South Bend	1	6	27,995	30	839,850	839,850
	Elkhart	1	2	9,675	30	290,250	290,250
Fort Wayne	Fort Wayne	2	8	18,195	30	545,850	1,091,700
Gary	Gary	1	6	27,995	30	839,850	839,850
	Hammond	1	6	27,995	30	839,850	839,850
	East Chicago	1	2	9,675	30	290,250	290,250
	Portage	1	2	9,675	30	290,250	290,250
Total		14	60				8,421,900

Note: GCA calculations, 1978.

TABLE 89. MAJOR EQUIPMENT ITEMS REQUIRED FOR ALTERNATIVE 6

Item	Remarks	Unit cost ($)
1. Emissions analyzer	Analyzer should be capable of measuring CO and HC. Extremely wide range in analyzer costs; cheaper analyzers found to be inadequate. Analyzers should be capable of being tied into computer data handling systems. Costs based on discussions with manufacturers (Olson-Horiba, Hamilton Test Systems).*	21,500
2. CRT terminals	Two required per lane. Costs based on literature and discussion with manufacturing representatives (Honeywell, Digital, Olivetti, Sperry Univac) and experiences of other states.	2,500
3. Minicomputer	One required per facility. Included in facility furnishings cost.	80,000
4. Miscellaneous tools	As required.	1,000

*Emission analyzers costed for centralized lanes differ from garage analyzers costed at $3,000 as follows: (1) to decrease purge time to a level acceptable for a high volume application, the analyzer has refrigerated bath and filtration capabilities not available in a garage analyzer; (2) to eliminate CO_2 and H_2O interference, the centralized lane analyzer has dual detector capabilities; (3) to allow computer tie-in, the analyzer is capable of linearized output; (4) to correct for high and variable ambient concentrations of HC and CO, "flowing reference cells" are included.

Note: GCA calculations, 1978.

TABLE 90. EQUIPMENT COSTS AS A FUNCTION OF FACILITY CONFIGURATION FOR ALTERNATIVE 6

Number of lanes	Equipment cost ($)
1	107,500
2	135,000
3	162,500
4	190,000
5	217,500
6	245,000

Note: GCA calculations, 1978.

TABLE 91. EQUIPMENT COSTS FOR ALTERNATIVE 6

Location		Facilities	Number of lanes	Cost per facility ($)	Total cost ($)
Urbanized area	Municipality				
Indianapolis	Indianapolis	2	12	245,000	490,000
	Nora	1	6	245,000	245,000
	South Port	1	6	245,000	245,000
Louisville	Clarksville	1	2	135,000	135,000
	New Albany	1	2	135,000	135,000
South Bend	South Bend	1	6	245,000	245,000
	Elkhart	1	2	135,000	135,000
Fort Wayne	Fort Wayne	2	8	190,000	380,000
Gary	Gary	1	6	245,000	245,000
	Hammond	1	6	245,000	245,000
	East Chicago	1	2	135,000	135,000
	Portage	1	2	135,000	135,000
Total		14	60		2,770,000
Additional equipment required:					
Central computer					250,000
Maintenance/calibration vans (6)					84,000
Security systems					15,400
Total equipment costs					3,119,400

Note: GCA calculations, 1978.

Personnel Training--

Applying staffing rates previously discussed, the basic operating personnel requirements for alternative 6 are:

- 14 managers
- 14 assistant managers
- 180 inspectors
- 6 maintenance/calibration personnel

The training costs per individual, as discussed in Section 2, are $53.00, $43.00, and $16.00 for instructors, investigators and inspectors. Applying the same assumptions as previously discussed, the startup cost of inspector training can be computed as:

(14 managers)($53.00) + (14 assistant managers)($16.00)
+ (180 inspectors)($16.00) + (6 maintenance/calibration personnel)($16.00)
= $3,942.00

Personnel Salaries--

Personnel costs are based on the following assumptions:

- all managerial personnel will be phased into the program 6 months prior to startup
- inspectors will be phased in 1 month prior to startup
- wage scales are:[*]
  - Managers, $15,000 per year or $1,250 per month
  - Assistant managers, $13,000 per year or $1,083 per month
  - Maintenance/calibration personnel, $12,000 per year or $1,000 per month
  - Inspectors, $10,000 per year or $833 per month
- 25 percent is added to these figures to cover personnel overhead

The total cost for test personnel wages can be computed for alternative 6 based on these assumptions. Test personnel costs are:

[(14 managers)($1,250/month)(6 months)
+ (14 assistant managers)($1,083/month)(6 months)
+ (6 maintenance/calibration personnel)($1,000/month)(1 month)
+ (180 inspectors)($833/month)(1 month)] 1.25 = $439,890

---

[*] State of Indiana Classification Plan and Salary Schedule, July 1977.

The administrative personnel costs must also be included in the startup phase. These persons would be phased in 18 months prior to startup as previously discussed. The total cost for this item is $1,109,813 and is broken down in Table 92.

The total personnel startup salaries, then, will be the sum of test personnel and administrative personnel costs or $1,549,703.

Public Information Program--

The cost estimate for this element is the same for alternative 6 as discussed for alternative 5 in Section 7; that is, a budget for initial public information should be $0.12 per vehicle to be tested, or $274,664.

Annual Operating Costs

This cost category includes all costs associated with actual program operation. Administrative programs such as ongoing public information and inspector/mechanic training programs are not included here.

Facility Personnel--

Based on facility staffing requirements and annual salary figures for the various job categories, annual personnel costs can be computed. This estimate appears in Table 93.

Maintenance--

Primary costs for maintenance reflect equipment repair and preventive maintenance. In this connection, the yearly cost of these items was estimated to be 20 percent of the original cost. Specifically, this would be:

$$\$2,770,000 \times 0.20 = \$554,000$$

Calibration Costs--

The recurring annual cost of equipment calibration consists of the cost of calibration gases plus the operating costs of calibration/maintenance vans. Table 94 breaks down the $52,800 annual cost estimate for this expense.

Utilities/Supplies/Services--

Utilities--The annual costs for utilities were derived from electric usages experienced by other states. For alternative 6, these were found to be: 120 kWh/day for each lane, plus 325 kWh/day per facility. Per kilowatt costs were obtained from Indianapolis Power and Light, and were found to be $0.04/kWh on average. The annual cost, then, is calculated below.

$$(60 \text{ lanes})(120 \text{ kWh/day lane})(\$0.04/\text{kWh})(250 \text{ operating day/yr})$$
$$+ (14 \text{ facilities})(325 \text{ kWh/day facility})(\$0.04/\text{kWh})(250 \text{ operating day/yr})$$
$$\$72,000 + 45,500 = \$117,500$$

TABLE 92. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP - ALTERNATIVE 6

Job title	Number of positions	Annual salary per position ($)	Total 18-month salaries for all positions ($)
Administrator	1	25,000	37,500
Assistant Administrator (support)	1	17,000	25,500
Assistant Administrator (operations)	1	21,000	31,500
Legal Counsel	1	15,000	22,500
Purchasing Officer	1	13,000	19,500
Contracts Officer	1	13,000	19,500
Accountant	1	12,000	18,000
Engineer	1	10,400	15,600
Systems Analyst	1	11,000	16,500
Statistician/Programmer	1	10,500	15,750
Mechanic Training Coordinator	1	13,000	19,500
Regional Manager	6	21,500	193,500
Regional Inspector (licensing)	6	15,500	139,500
Regional Manager (surveillance)	6	15,500	139,500
Regional Public Information Coordinator	6	15,500	139,500
Mechanic Training Instructor	1	11,000	16,500
Instrument Repair Technician	1	12,000	18,000
Total salaries for 18 months			887,850
Overhead at 25 percent of salary			221,963
Total Administrative personnel costs			1,109,813

Note: GCA calculations, 1978.

TABLE 93. ANNUAL SALARY EXPENSE FOR FACILITY PERSONNEL

Job title	Number of positions	Annual salary per position ($)	Total annual salary for all positions ($)
Manager	14	15,000	210,000
Assistant Manager	14	13,000	182,000
Maintenance/Calibration Personnel	6	12,000	72,000
Inspector	180	10,000	1,800,000
Total salaries			2,264,000
Overhead at 25 percent			566,000
Total costs			2,830,000

Note: GCA calculations, 1978.

TABLE 94. ANNUAL CALIBRATION COSTS FOR ALTERNATIVE 6

Item	Cost ($)
Gases (20 sets per year at $200 per set)	4,000
Maintenance on van	2,800
Insurance on van and equipment	1,000
Fuel, oil, etc.	1,000
Per calibration van cost	8,800
vans	6
annually	52,800

Note: GCA calculations, 1978.

Insurance--It is assumed that the contractor-run operation would cover fire and theft as well as liability insurance. Based on previous experience (Arizona, HTS), insurance costs generally run about $1,500 per lane. Annual costs based on this estimate are calculated below:

(60 lanes)($1,500 per lane) = $90,000

Computer Operation--Central computer operation costs for automated inspection systems have been estimated at $0.15 per test. This would compute to an annual cost of $343,330 for alternative 6.

Inspection forms--In addition to the computer operation costs, a cost of $0.03 per test has been estimated based on previous experience (Arizona). This computes to a total annual cost of $68,666 for alternative 6.

Taxes--The tax cost for the contractor network for alternative 6 is calculated based on property tax rates obtained from the Indiana Board of Tax Commissioners. Tax costs are summarized in Table 95.

Uniforms--Uniforms cost $125.00 per year annually, based on previous experience (Arizona). For alternative 6, this amounts to $26,750 annually for 214 uniformed employees.

Security systems--Based on experiences of other states, the annual cost for upkeep and service of security systems is $850 per facility. For alternative 6, then, an annual cost of $11,900 is estimated.

The costs for the utilities/supplies/services category of annual operating costs are summarized in Table 96.

Annual Administrative Costs

Program Administration--

Annual administrative personnel costs are computed from the personnel requirements and salaries delineated previously. The annual cost computation is shown in Table 97.

Public Information--

The annual cost of a public information program is estimated to be $0.12 per test as previously discussed. For this alternative, this amounts to $274,664 annually.

Personnel Training--

This element reflects the ongoing requirement to train inspectors. The replacement rate (new inspectors to be trained annually) was estimated to be 10 percent of the inspector force, based on the experience of the Arizona program. The inspector force for this alternative is 180, which relates to an annual training rate of 18 new inspectors. The cost for each individual trained, derived previously, is $16.00; therefore, the entire annual cost is $288.00.

TABLE 95. TAXES FOR ALTERNATIVE 6*

Location		Facilities	Number of lanes	Value of taxable property ($)	Tax rate (percent)	Annual taxes ($)
Urbanized area	Municipality					
Indianapolis	Indianapolis	2	12	2,829,304	1.2694	35,915
	Nora	1	6	1,414,652	1.2694	17,958
	South Port	1	6	1,414,652	0.9927	14,043
Louisville	Clarksville	1	2	538,957	0.9850†	5,309
	New Albany	1	2	538,957	0.6350	3,422
South Bend	South Bend	1	6	1,414,652	1.2530	17,726
	Elkhart	1	2	538,957	0.9801	5,283
Fort Wayne	Fort Wayne	2	8	1,901,118	1.0698	23,627
Gary	Gary	1	6	1,414,652	1.7442	24,674
	Hammond	1	6	1,414,652	1.8017	25,488
	East Chicago	1	2	538,957	1.2366	6,665
	Portage	1	2	538,957	1.0340	5,573
Total				14,498,467		185,683

*Tax rates obtained from the Indiana Board of Tax Commissioners.

†No figure available. County average used.

Note: CCA calculations, 1978.

TABLE 96. ANNUAL COST FOR UTILITIES, SERVICES, AND SUPPLIES

Category	Annual operating cost ($)
Utilities	117,500
Insurance	90,000
Computer operation	343,330
Inspection forms	68,666
Calibration costs	52,800
Taxes	185,683
Uniforms	26,750
Security systems	11,900
Total	896,629

Note: GCA calculations, 1978.

TABLE 97. ANNUAL ADMINISTRATIVE PERSONNEL COSTS - ALTERNATIVE 6

Job title	Number of positions	Annual salary per position ($)	Total annual salaries for all positions ($)
Administrator	1	25,000	25,000
Assistant Administrator (support)	1	17,000	17,000
Assistant Administrator (operations)	1	21,000	21,000
Legal Counsel	1	15,000	15,000
Purchasing Officer	1	13,000	13,000
Contractor Officer	1	13,000	13,000
Accountant	1	12,000	12,000
Engineer	1	10,400	10,400
Systems Analyst	1	11,000	11,000
Statistician/Programmer	1	10,500	10,500
Mechanic Training Coordinator	1	13,000	13,000
Regional Manager	6	21,500	129,000
Regional Inspector (licensing)	6	15,500	93,000
Regional Manager (surveillance)	6	15,500	93,000
Regional Public Information Coordinator	6	15,500	93,000
Mechanic Training Instructor	1	11,000	11,000
Instrument Repair Technician	1	12,000	12,000
Total salaries			591,900
Overhead at 25 percent			147,975
Total Annual Administrative Costs			739,875

Note: GCA calculations, 1978.

TOTAL ALTERNATIVE COSTS

The total cost of the contractor-run portion of alternative 6 is summarized in Table 98. Capital costs are $14,847,868, one-time startup costs are $3,335,236, and ongoing annual operating and administrative expenses amount to $4,280,629 and $1,014,827, respectively.

FEE COMPUTATION

The cost of an emissions inspection to motorists in the five urbanized areas is given by the following formula:

$$\text{Inspection fee} = \frac{\text{Total annual costs}}{\text{Total inspections required}}$$

The capital costs and startup costs presented in the previous tables are converted to annual figures by use of the amortization factors described in Section 2. Annual operating and administrative costs are then added to the annualized capital and startup costs to obtain total annual costs in real (constant) 1978 dollars. The fee, f_c, is derived by dividing the total annual costs by the annual number of paid inspections. This fee is in 1978 dollars, and thus must be increased over time to compensate for inflation. It is calculated in Table 99. These fees were calculated on the assumptions that retests of failed vehicles cost the same amount as initial inspections of these vehicles. If it is decided that retests should be free, the fee would be 1.3 times the above fees, since there is a 30 percent stringency factor. Table 100 presents contractor fees for alternative 6 for both paid and free retests.

DETERMINATION OF THE CERTIFIED STATE INSPECTION STATION NETWORK

The certified state inspection station (CSIS) network for alternative 6 will be statewide. Within five urbanized areas (the Indianapolis, Louisville, South Bend, Fort Wayne and Gary areas) the CSIS network will perform safety inspections only. In the remainder of the state the CSIS network will perform combined emissions and safety inspections.

Relevant Vehicle Population

Since the type of inspection performed by a CSIS is determined by its location (whether or not it is in an urbanized area), the 1987 vehicle population has been broken down in Section 2 on an urbanized-rural basis. Multiplying the 1987 population figure by 1.3 yields the number of inspections that will have to be performed: this accounts for the reinspections that result from a 30 percent stringency rate. The number of inspections to be performed in 1987 are reported in Table 101.

DISTRIBUTION OF CERTIFIED STATE INSPECTION STATIONS

For administrative purposes, Indiana has been divided into six regions (see Figure 9). Table 102 reports the expected CSIS network for 1987 in terms of these regions. The number of stations in the 1987 network is assumed

TABLE 98. CONTRACTOR NETWORK COST SUMMARY - ALTERNATIVE 6

Cost category	Cost element	Amount ($)	Total category cost ($)
Capital costs	1. Land investment	3,306,568	
	2. Building investment	8,421,900	
	3. Equipment costs	2,770,000	
	4. Central computer	250,000	
	5. Maintenance vans	84,000	
	6. Security systems	15,400	
Total			14,847,868
One-time startup costs	1. Land acquisition	364,737	
	2. Facilities planning	842,190	
	3. Program design	100,000	
	4. Data software	200,000	
	5. Personnel training	3,942	
	6. Personnel salaries and overhead	1,549,703	
	7. Initial public relations	274,664	
Total			3,335,236
Annual operating costs	1. Facility personnel	2,830,000	
	2. Maintenance	554,000	
	3. Utilities, services, supplies	896,629	
Total			4,280,629
Annual administrative costs	1. Administrative salaries	739,875	
	2. Ongoing public relations	274,664	
	3. Personnel training	288	
Total			1,014,827

Note: GCA calculations, 1978.

TABLE 99. CONTRACTOR FEE COMPUTATION - ALTERNATIVE 6, 1987

(when i = 0.03)	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital costs			
1. Land	3,306,568	0.03	99,197
2. Buildings	8,421,900	0.067	564,267
3. Equipment	3,119,400	0.2184	681,277
II. Startup costs	3,335,236	0.2184	728,416
III. Operating costs	4,280,629	1.0	4,280,629
IV. Administrative costs	1,014,827	1.0	1,014,827
Total			7,368,613

$f_{c_{0.03}}$ cost per inspection = $7,368,613 /2,288,868 = $3.219

(when i = 0.06)	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital costs			
1. Land	3,306,568	0.06	198,394
2. Buildings	8,421,900	0.087	732,705
3. Equipment	3,119,400	0.2374	740,546
II. Startup costs	3,335,236	0.2374	791,785
III. Operating costs	4,280,629	1.0	4,280,629
IV. Administrative costs	1,014,827	1.0	1,014,827
Total			7,758,886

$f_{c_{0.06}}$ cost per inspection = $7,758,886 /2,288,868 = $3.390

Note: GCA calculations, 1978

TABLE 100. CONTRACTOR FEES - ALTERNATIVE 6 (CONSTANT 1978 DOLLARS)

	i = 0.03	i = 0.06
Free retests	4.185	4.407
Paid retests	3.219	3.390

Note: GCA calculations, 1978

TABLE 101. ANNUAL NUMBER OF INSPECTIONS REQUIRED, 1987, CSIS NETWORK FOR ALTERNATIVE 6

Urbanized/area county	Number of inspections
Indianapolis	
Marion	887,592
Hamilton	32,544
Johnson	40,990
Louisville	
Clark	62,310
Floyd	45,878
South Bend	
St. Joseph	216,455
Elkhart	76,008
Fort Wayne	
Allen	303,544
Gary-Hammond	
Lake	553,979
Porter	69,568
Total	2,288,868
Remainder of state	3,797,628

Note: GCA calculations, 1978.

TABLE 102. EXPECTED 1987 CSIS NETWORK FOR NONURBANIZED PORTIONS OF INDIANA

Location	Rural parts of urbanized counties	Rural counties
Northwest Indiana	75	372
North Central Indiana	41	394
Northeast Indiana	22	504
Central Indiana	63	471
Southeast Indiana	21	484
Southwest Indiana	0	458
Total	222	2,683
Statewide total		2,905

Note: GCA calculations, 1978.

to be 90 percent of that in the present CSIS network; an estimated decrease of 10 percent in the number of private garages participating as CSIS is expected due to higher equipment costs associated with emissions inspections. Since implementing alternative 6 would not affect CSIS in urbanized areas, only nonurbanized CSIS's are reported here.

Based on the anticipated 1987 inspection requirements for nonurbanized parts of the state (3,797,628) and the size of the rural CSIS network (2,905), each CSIS will have to perform approximately 1,300 inspections yearly. Assuming that inspections are performed 250 days per year, this means each CSIS must perform an average of 5.2 inspections daily. Since these inspections will be combined emissions and safety inspections which take 20 minutes, each CSIS should have to devote slightly under 2 hours per day to inspections.

Requirements for Quality Control

It is especially important that an effective system for guaranteeing a high level of quality control over the CSIS network be maintained. A CSIS network implies a number of HC/CO analyzers that must be accurately calibrated and checked frequently; U.S. EPA regulations require monthly calibrations. For this purpose the agency overseeing the I/M program should maintain a fleet of inspection and licensing vans (ILV).

These vehicles will be equipped to check the accuracy of HC/CO analyzers in use at certified state inspection stations. Based on monthly inspections, it is assumed that one inspection and licensing van is needed to properly oversee 70 certified state inspection stations. ILV requirements include an additional 15 percent over this figure to account for breakdowns, scheduled maintenance, etc.

Complaints investigation vehicles are also needed. Approximately one such vehicle per 100 CSIS locations should be sufficient; a 15 percent reserve cushion is also assumed. The inspection and licensing van and complaints investigation vehicle requirements are broken down by region and presented in Table 103.

FEE CALCULATIONS FOR THE CERTIFIED STATE INSPECTION STATION NETWORK

CSIS Inspection Fee Computation

Fee calculations have been made based on both free and paid reinspections. As derived in Section 2, the following formula determines the fee a CSIS will charge:

$$N (P - F) = A + (L + 0) N T + X + M + G$$

where N = paid inspections performed at one CSIS in 1 year.

P = price charged by a CSIS for an inspection.

F = administrative "sticker" fee paid to the state by a CSIS for each safety inspection.

TABLE 103. INSPECTION AND LICENSING VANS AND COMPLAINTS VEHICLES NEEDED TO ASSURE QUALITY CONTROL OVER THE CSIS NETWORK - ALTERNATIVE 6

Region	Number of CSIS	Number of inspection and licensing vans	Number of complaints vehicles
Northwest Indiana	447	8	6
North Central Indiana	435	8	5
Northeast Indiana	526	9	6
Central Indiana	534	9	6
Southeast Indiana	505	9	6
Southwest Indiana	458	8	6
Total	2,905	51	35

Note: GCA calculations, 1978.

A = annualized cost of owning an HC/CO analyzer, assumed to be $655

L = hourly labor cost, assumed to be $7.33 including labor overhead

Ø = overhead cost for the bay used to perform the CSIS inspection, assumed to be $8.67 per hour

T = length of time needed to perform an inspection. An emissions only test is assumed to take 5 minutes, a safety inspection is 15 minutes long, and a combined test lasts 20 minutes

X = the annual licensing fee paid by the station to the state, here assumed to be $40.00

M = maintenance cost for an HC/CO analyzer, assumed to be 20 percent of purchase price or $600 per year

G = cost of calibration gas for HC/CO analyzer, assumed to be $200 per year.

The critical values in this formula are throughput (N) and length of a test (T). The cost of performing a combined safety and emissions test with paid retests is calculated below:

$$\text{Average annual throughput} = \frac{3{,}797{,}628}{2{,}905} = 1{,}307$$

$$(1{,}307)(P - F) = \$655 + (\$16.00)(1{,}307)(1/3) + \$40.00 + \$600.00 + \$200.00$$

$$(P - F) = (\$1{,}495 + 6{,}970.66)\ /\ 1{,}307$$

$$= \frac{\$8{,}465.66}{1{,}307}$$

$$= \$6.4772$$

Thus, with paid reinspections, a combined test costs $6.48 per inspection plus the state sticker fees. If free emissions reinspections are assumed, then the cost per emission inspection ($6.48 - 4.00 = $2.48) must be distributed over 100 percent of the vehicle population inspected. With free reinspections, the cost rises to $4.00 + 3.224 = $7.224.

It is useful, for purposes of comparison with the other alternatives, to calculate that part of the cost of a combined inspection that emissions testing generates. This figure can be derived using the same cost formula as above but substituting a 5-minute throughput rate for the 20-minute rate used above.

$$(1{,}307)(P - F) = \$655 + (\$16.00)(1{,}307)(1/12) + \$40.00 + \$600.00 + \$200.00$$

$$(P - F) = \frac{\$3{,}237.67}{1{,}307} = \$2.48$$

If it is decided that free retests are desirable, total emissions test costs are distributed over a smaller number of inspections, increasing the above figure to $3.22. The costs of combined emission and safety testing by the CSIS network are summarized in Table 104.

TABLE 104. CSIS INSPECTION FEES, ALTERNATIVE 6, 1987
(CONSTANT 1978 DOLLARS)

Type of inspection	Paid emission retests	Free emission retests
Safety	$4.00 + 0.50*	
Emissions	2.48	3.22
Total costs	6.98	7.72

*Safety inspection includes free retest policy. Costs are $4.00 for the CSIS plus $0.50 for the safety sticker.

Note: GCA calculations, 1978.

State Emissions Sticker Fee Computation

It should be emphasized that these figures do not represent the entire fee each motorist will pay. In addition to the cost of performing inspections, the fee collected must include the "sticker" fee, (F), levied by the state to cover program costs in rural areas. These costs include the purchase price of inspection and licensing vans and equipment, complaints investigation vehicles, operating personnel training costs and salaries, etc. No administrative costs nor public information costs are included. It is assumed that no additional state- or regional-level administrative personnel will be required to oversee CSIS operations beyond the administrative personnel and costs included in the $4.50 safety inspection fee. More careful scrutiny will be required in the next phase. The sticker fee is calculated in Table 105.

By adding the state emissions sticker fee, F, to the CSIS inspection costs calculated previously, the total charge, P, for an inspection in non-urbanized areas is obtained. This total charge is presented in Table 106.

Public Information Program

Both the initial and the ongoing cost for a public information program for the certified state inspection station network coverage of alternative 6 is assumed to be higher than the cost necessary for the contractor-operated portion of this alternative. This is due to the fact that this aspect of this alternative is thought to be especially difficult to present to the public. Due to the geographic coverage specifications (two different coverage areas), the degree of public education necessary for this alternative is higher than in previous alternatives.

TABLE 105. STATE STICKER FEE CALCULATIONS - ALTERNATIVE 6

when i = 0.03	Cost ($)	Amortization factor	Annualized cost ($)
I. Capital costs			
1. 51 inspection and licensing vehicles	448,800	0.2184	98,018
2. 35 complaints vehicles	175,000	0.2184	38,220
II. One-time startup costs			
1. Personnel training	3,698	0.2184	808
2. Personnel salaries and overhead	2,269,688	0.2184	495,700
III. Annual operating costs			
1. Maintenance	124,760	1.0	124,760
2. Calibration	448,800	1.0	448,800
3. Personnel salaries and overhead	1,513,125	1.0	1,513,125
Total			2,719,431

$$\text{State emissions sticker fee}_{0.03} = \frac{\$2,719,431}{3,797,628} = \$0.716$$

(continued)

TABLE 105 (continued).

	when i = 0.06	Cost ($)	Amortization factor	Annualized cost ($)
I.	Capital costs			
	1. 51 inspection and licensing vehicles	448.800	0.2374	106,545
	2. 35 complaints vehicles	175,000	0.2374	41,545
II.	One-time startup costs			
	1. Personnel training	3,698	0.2374	878
	2. Personnel salaries and overhead	2,269,688	0.2374	538.824
III.	Annual operating costs			
	1. Maintenance	124,760	1.0	124.760
	2. Calibration	448,800	1.0	448,800
	3. Personnel salaries and overhead	1,513,125	1.0	1,513,125
	Total			2,774,477

$$\text{State emissions sticker fee}_{0.06} = \frac{\$2,774,477}{3,797,628} = \$0.731$$

Note: GCA calculations, 1978.

A more extensive public relations campaign for alternative 6 is therefore assumed to entail a cost of $0.25 per vehicle tested. This represents a total cost of $730,313 for the vehicle population mentioned (2,921,253 vehicles) which will be inspected in this CSIS network. This cost has not been added to other cost computations, as it varies considerably depending on the campaign design.

A more specific cost estimate for public relations may be added to other program costs in the future as the public relations program aspects become more concrete. The public relations campaign for emissions testing in the CSIS network may also be coordinated jointly with the existing program used for safety inspections in the future years of an I/M regime.

POSSIBLE EXTERNALITIES AND LEGISLATIVE CONSIDERATIONS

This section discusses only those possible externalities and legislative issues specifically affecting alternative 6. While no particular problems were uncovered that could affect the legality of this alternative on either the state or federal level, there are notable practical and political uncertainties that should be considered.

This alternative provides for statewide emissions testing. Within five urbanized areas an emissions inspection will be conducted by a contractor-operated network, and the CSIS network will continue to perform safety inspections. Outside these urbanized areas an emissions test will be combined with safety inspections and conducted by the CSIS network.

TABLE 106. TOTAL INSPECTION CHARGE (P), CSIS NETWORK, ALTERNATIVE 6, 1987 (CONSTANT 1978 DOLLARS)

	i = 0.03	i = 0.06
Paid retests	7.70	7.71
Free retests	8.65	8.67

Note: GCA calculations, 1978.

The inclusion of an emission inspection along with safety inspections at rural certified state inspection stations will add roughly 1/2 hour per day to the time each station devotes to inspection duties. This additional work should not overtax the capacity of the rural CSIS network. Thus, adding emissions testing in rural areas as this alternative proposes, is a practical possibility.

Program coverage areas are defined by "urbanized area" boundaries established by several metropolitan planning organizations with regional planning needs in mind. In general, the public recognizes and understands boundaries, such as county lines and city limits, that are used for administrative purposes.

Because the urbanized area designations are unfamiliar to most citizens, a major public information program will be required to familiarize the public with these designations. The public information problem may be further complicated because the metropolitan planning organizations periodically redefine their "urbanized areas." Also, since these urbanized areas are not presently used for administrative purposes, the state cannot easily tie motor vehicle registration, enforcement, etc., for this alternative into existing administrative procedures. A new system will have to be devised to determine which vehicles are registered within the urbanized areas and which are not. Only Marion County is fully contained within an urbanized area boundary; urbanized areas include portions of nine other counties. It will be no easy matter to determine which vehicles in these nine counties are registered within the urbanized areas. Postal addresses are inappropriate, because some households have postal addresses that do not correspond with their actual places of residence. Also, some forms of addresses (e.g., route numbers) are not specific enough to locate them inside or outside of the urbanized areas.

As alternative 6 is now defined, motorists residing within the five urbanized areas will have to travel to a CSIS for a safety inspection and then proceed to a contractor-operated facility to undergo an emissions inspection. The "two-stop" nature of this alternative may generate adverse public reaction. Such resistance is more likely to occur if the citizens of Indiana are aware of inspection programs elsewhere which combine both emissions and safety inspections in one facility.

EMISSION REDUCTION BENEFITS

Inspection/maintenance is designed to reduce automobile emissions in order to improve ambient air quality by lowering pollution levels. The magnitude of potential emissions reductions is dependent on the size of the vehicle population covered by a mandatory program. 1987 tailpipe emission reductions that would result from implementing I/M were calculated using the Environmental Protection Agency's Mobile I computer routine.

The results of these calculations are reported in Tables 107 and 108. Statewide vehicle HC emissions with I/M will be 234,855 kg/day. This represents a 26.3 percent reduction over emission levels that would occur in 1987 in the absence of I/M. Carbon monoxide vehicle emissions will be 2,282,249 kg/day statewide in 1987 with I/M. This is a 32.1 percent reduction over 1987 non-I/M levels.

TABLE 107. DAILY HYDROCARBON EMISSIONS FOR ALTERNATIVE 1 (kg/day)

Area	Heavy-Duty Trucks									Light-Duty Vehicles												All Vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M Auto	1987 With I/M Auto	1975 LD-Truck	1982 LD-Truck	1987 Without I/M LD-Truck	1987 With I/M LD-Truck	1975 Total	1982 Total	1987 Without I/M Total	1987 With I/M Total	1975	1982	1987 Without I/M	1987 With I/M	Percent Reduction 1977 to 1987 With I/M	Percent Reduction 1987 Without I/M to 1987 With I/M
Allen County	239	260	228	1,480	1,139	516	1,747	1,399	744	22,780	11,684	6,999	4,642	3,480	2,436	1,313	1,033	26,264	14,120	8,312	5,675	28,011	15,300	9,033	6,419	77.1%	29.1%
Clark County	509	738	551	389	275	165	976	1,013	696	9,686	4,895	2,808	2,083	2,706	1,897	1,217	888	12,392	6,792	4,025	2,971	13,368	7,805	4,721	3,367	73.3%	25.4%
Floyd County	231	328	237	171	188	57	402	418	314	3,720	2,112	1,338	918	1,103	832	563	388	4,839	2,944	1,893	1,306	5,271	3,362	2,203	1,622	69.2%	26.3%
Lake and Porter Counties	2,766	3,050	2,446	18,130	12,410	7,360	20,896	15,460	9,772	37,332	16,025	8,567	5,586	2,073	6,386	5,783	3,777	39,406	22,409	14,350	9,373	60,298	38,076	24,122	19,145	68.2%	20.6%
Marion County	1,480	1,786	1,371	15,119	11,395	7,386	16,609	13,291	8,765	76,084	30,637	22,386	15,276	10,060	7,085	6,798	3,128	88,353	40,042	29,184	18,404	102,962	53,941	36,346	27,169	73.6%	25.2%
St. Joseph County	281	291	221	1,720	1,136	516	2,001	1,429	735	23,507	11,180	6,124	4,116	4,299	2,665	1,688	1,080	27,626	13,811	7,752	5,196	29,827	15,240	8,487	5,929	80.1%	29.9%
Remainder of State	6,480	6,096	5,136	44,637	46,366	27,308	51,293	50,614	32,444	432,512	248,406	156,228	107,775	80,127	63,596	44,306	30,563	512,639	312,002	200,536	138,340	563,932	362,616	233,180	171,004	69.7%	22.3%
Statewide	10,099	12,400	10,190	83,820	72,238	43,300	93,930	80,638	53,490	585,800	331,980	205,290	140,325	113,890	80,480	59,780	40,840	700,750	410,748	265,030	181,165	803,670	503,370	318,720	234,655	70.7%	26.3%

TABLE 108. DAILY CARBON MONOXIDE EMISSIONS FOR ALTERNATIVE 1 (kg/day)

Area	Heavy-Duty Trucks									Light-Duty Vehicles												All Vehicles					
	1975 Diesel	1982 Diesel	1987 Diesel	1975 Gasoline	1982 Gasoline	1987 Gasoline	1975 Total	1982 Total	1987 Total	1975 Auto	1982 Auto	1987 Without I/M Auto	1987 With I/M Auto	1975 LD-Truck	1982 LD-Truck	1987 Without I/M LD-Truck	1987 With I/M LD-Truck	1975 Total	1982 Total	1987 Without I/M Total	1987 With I/M Total	1975	1982	1987 Without I/M	1987 With I/M	Percent Reduction 1977 to 1987 With I/M	Percent Reduction 1987 Without I/M to 1987 With I/M
Allen County	1,783	1,628	1,702	15,661	18,701	11,765	17,436	20,329	13,467	166,166	102,517	59,307	32,443	34,180	21,762	15,713	8,547	180,267	124,239	75,022	41,062	205,693	144,568	88,489	54,529	73.5%	38.4%
Clark County	4,213	4,066	4,181	4,362	4,448	3,236	8,555	8,514	7,415	72,770	45,380	26,083	15,487	18,945	17,433	12,988	7,898	91,715	62,821	39,036	23,100	100,270	71,335	46,460	30,425	69.5%	34.5%
Floyd County	1,183	1,703	1,950	1,046	1,780	1,159	3,451	3,482	3,117	29,616	20,177	12,476	7,136	7,752	7,715	6,078	3,483	37,368	27,932	18,566	10,639	40,810	31,396	21,671	13,756	66.3%	36.5%
Lake and Porter Counties	21,487	19,299	18,830	262,236	196,060	108,996	223,951	213,359	128,816	236,651	147,040	83,712	46,327	109,825	99,115	65,271	36,112	348,476	246,986	148,983	82,438	592,067	460,323	277,799	211,250	64.3%	24.0%
Marion County	11,609	10,491	11,157	141,155	143,827	100,098	152,764	154,318	111,255	645,583	383,538	213,619	115,275	70,916	69,440	36,867	19,886	726,497	454,976	250,486	135,158	877,261	609,296	361,721	246,416	71.9%	31.9%
St. Joseph County	2,026	1,722	1,703	18,466	19,461	11,637	20,492	21,183	13,340	179,815	102,164	31,313	20,643	37,890	25,368	15,918	9,192	218,714	127,732	67,323	38,037	231,206	148,915	80,363	52,177	77.4%	35.1%
Remainder of State	28,639	29,662	36,760	516,414	756,013	666,381	545,053	785,315	703,030	2,080,539	2,087,539	1,340,890	732,426	619,735	470,011	433,730	236,037	3,317,274	2,368,356	1,779,448	968,463	3,860,327	3,154,665	2,484,718	1,673,513	56.7%	32.6%
Statewide	71,750	68,580	77,290	887,940	1,138,850	903,210	960,690	1,207,440	982,500	4,261,940	2,901,130	1,792,410	978,750	696,370	711,080	580,520	321,080	4,938,310	3,613,060	2,370,930	1,299,767	5,908,000	4,820,480	3,361,436	2,282,269	61.4%	32.1%

Reproduced from best available copy.

SECTION 9

POSSIBLE EXTERNALITIES: INDIRECT IMPACTS

INTRODUCTION

The subject of indirect impacts arising from an I/M program is quite complex. To provide a complete picture of the program, indirect, as well as direct impacts should be considered. The issues raised by these potential effects are extremely difficult to quantify. Many of these costs and benefits are qualitative and, as such, highly subjective. Also, much of the data that are available pertaining to these issues are either incomplete or inconclusive. In light of the problems inherent in these issues, attempts to completely quantify them would add confusion rather than provide useful information. In consideration of this, the discussion that follows is fairly general and primarily qualitative in nature. It is intended to identify some of the pertinent issues and the likely directions, if not the magnitudes, of various impacts.

I/M is designed to achieve a reduction in motor vehicle emissions levels. All other effects the program has are considered secondary or indirect. This section opens with a general discussion of these secondary impacts. General impacts on the vehicle user population and the repair industry are also noted. Some of the impacts of program implementation that are dealt with in this section are:

- Health benefits
- Impact on vehicle performance and vehicle life
- Impact of required maintenance costs
- Time costs of traveling to and from the inspection site
- Impact on repair industry employment

Once the general groundwork has been established, the effect of different alternatives on the magnitudes of these externalities is considered. The implications of contractor facilities versus certified state inspection stations will then be discussed.

GENERAL PROGRAM IMPACTS

General Impacts

There are a number of benefits that are likely to accrue to society at large from a successfully implemented I/M program. Improving ambient air quality should create significant health benefits. A reduction in respiratory related medical problems is likely. This will, in turn, lead to a series of secondary or indirect effects. The average longevity of the population should increase slightly and fewer days of production in industry will be lost due to illness.[1]

To date, a substantial investment has been made in pollution control equipment on automobiles. This investment will continue to grow as new cars equipped with emissions control devices are produced to replace older vehicles lacking them. Emissions control systems deteriorate steadily in efficiency with use, unless they are periodically maintained. If unchecked, this deterioration can completely eliminate the benefits of installing the systems to begin with. As, generally, there are no visible signs of this equipment deterioration and, therefore, no incentive to correct these undetected malfunctions, the necessary maintenance is not likely to occur. An I/M program can have a major impact by insuring the integrity of these control devices and protecting a nationwide investment that (it is estimated) will reach $150 billion by 1980.[2] Benefits accruing from foregone pollution costs may run to several billions of dollars per year nationwide.

Should a vehicle safety inspection program be implemented in conjunction with an I/M program, substantial operating economies are possible. Combining these two programs in one facility can avoid duplication of personnel and fixed costs. Overhead can be shared, land requirements for a combined setup would be less than separate facilities require, etc. The incremental cost of adding safety inspections to an I/M network would be lower than the cost of establishing it independently. One private contractor estimates that the addition of safety inspections to a fully operational loaded mode emissions testing facility would increase costs by roughly 20 to 30 percent. This estimate assumes the I/M facility has been designed with expansion in mind.

Impact on Vehicle Performance and Vehicle Life

The impact of I/M on these considerations is difficult to quantify. The studies to date have not been conclusive. They have centered on the way I/M affects short and long run vehicle deterioration curves. The short run deterioration curve reflects the rate at which a vehicle deteriorates after it has been tuned, while the long run curve reflects the overall degradation in vehicle performance that occurs as it ages. Both curves, especially the short run deterioration curve, influence vehicle performance while the slope of the long run curve is more likely to be the primary determinant of vehicle longevity.

A study of Colorado's I/M program indicates that after a vehicle is repaired under that program, the emission of hydrocarbons (HC) has deteriorated back to a prerepair condition in as little as 6 months.[3] However, this result is likely to be atypical since Colorado's program is carried out at high altitude where the engine adjustments needed to yield acceptable vehicle performance require frequent tune-ups. Another study, under more typical conditions, set the short run deterioration rate low enough so repaired vehicles remain above their prerepair level over a yearly inspection interval.[4]

To the extent that I/M influences the short run curve, it should have a positive impact on vehicle performance. If an engine stays closer to manufacturer's specifications, it should perform at a higher level due to I/M.

The influence on performance and longevity resulting from I/M's impact on the long run deterioration curve is unknown now. It seems sensible that a properly maintained vehicle will experience less wear than one that is not maintained to manufacturers' specifications. Assuming this relationship is true, I/M should have a positive effect on vehicle life.

At present there are no closely controlled studies which document the effects of I/M on vehicle performance and vehicle life. However, Hamilton Test Systems in Arizona, which has designed specific I/M programs for larger vehicle fleets, has reported that these fleet operators maintain detailed records of maintenance and operating costs for their vehicles over the life cycle of the vehicles. These records apparently document the decreased operating and maintenance costs they have experienced with I/M implementation, as well as improved vehicle reliability, as seen in towing records.[5]

Impact on Vehicle Owners

The improvement in fuel economy that results from an I/M program is an important benefit for vehicle owners. The total improvement in fuel economy varies according to the geographical coverage and is discussed in each individual alternative section. The vehicle owners view the fuel savings as an individual economic issue, whereas the total or aggregate fuel savings is actually an important energy conservation savings as well.

The cost savings that result from the improvement in fuel economy, the better engine performance and increased longevity are not readily apparent to the individual motorists, although the fleet owners who have good long-term records will be able to perceive these benefits over time. It is important, therefore, that the motoring public be made aware of these benefits.

On the other hand, the obvious costs of repairs for failed vehicles will be readily apparent to the vehicle owners. The question arises, however, as to how much of these repair costs should be directly attributable to the I/M program. While it is true that a vehicle owner is forced to make a repair if his vehicle does not comply, it is inaccurate to charge the entire cost of mandated repairs to I/M requirements. I/M will cause vehicles to be repaired more completely and frequently than they would be without it. Indeed, this is the purpose of I/M. But a fraction of the repair cost would have been incurred regardless. Estimates of the magnitude of this fraction vary from 25 to 75 percent.

This issue of mandated repairs is central to I/M program externalities. The costs of these repairs are a burden on the vehicle owner. These costs will not be distributed evenly throughout the population. It is safe to assume that older vehicles will generally be owned by individuals at the lower end of the economic spectrum. These vehicles are more likely to require repairs than newer vehicles. If these vehicles fail to meet I/M standards more frequently than newer vehicles, the burden of I/M could fall unevenly on lower income segments of the population. This uneven impact is partially mitigated by establishing exemptions to compliance based on vehicle age and ceilings on the dollar value of mandated repairs.

As the vehicle mix changes over time, this problem will become less severe than it may be now. As older vehicles, those that are costly to maintain to standards, drop out of the vehicle population, they will be replaced by used vehicles. Vehicles included in a mandatory I/M program are likely to be well maintained. It is possible that this may lower the overall cost of maintaining vehicles throughout their serviceable life.

This trend will be countered to a certain extent because vehicles filtering down via resale will be equipped with various emissions control devices. This equipment has been covered by a 50,000-mile guarantee by manufacturers as a result of federal warranty requirements. The useful life of emission control devices covered by warranty is not presently known. Of course, if these devices prove to be as durable as the vehicles in which they are installed, they will not create extra repair costs as these vehicles age. Should they require replacement after 50,000 miles but prior to the end of a vehicle's life, the cost of doing so will fall on the used car owner who is generally in a lower income category than the initial purchaser. Replacing control devices could become costly. Thus, if these devices do require extensive maintenance to be kept operating correctly near the end of a vehicle's life, I/M may impose a greater financial burden on the used vehicle owner than it will on the public at large. If this proves the case, it will add another reason for exempting vehicles reaching a certain age.

Establishing an accurate average cost for repairs that are induced by I/M is difficult. General data from existing programs can provide a starting point in contemplating the magnitude of this figure. For California's Riverside Trial Program, the average repair cost for a vehicle failing inspection, including parts, tax and labor was $11.42 when adjusted to remove voluntary repairs made at the time required repairs were performed.[6] This figure applies repair costs for a 40 percent stringency rate over the entire vehicle population tested. Average repair values for California were $27.33 and $32.08 for idle and loaded mode testing. In a similar study in Michigan these figures were $23.29 and $36.56.[7]

In these studies, the repair costs directly attributable to I/M may not be accurate. This is for two reasons. One reason, mentioned earlier, is that some of these repairs would have been made anyway, even if the I/M program was not in existence. Second, no accounting is made, nor can it be made with current data, of extra repair costs incurred in anticipation of inspection. It is likely that some vehicles that pass the first time through inspection have attained higher maintenance standards than they would have otherwise in order to avert failure and the inconvenience of traveling to the inspection site a second time for retesting.

The nature of repairs required to meet I/M standards for failed vehicles can help shed light on the burden noncomplying vehicle owners must bear. The Riverside Trial Program found that 66 percent of the diagnosed repair evaluations consisted of an imbalance in the idle air-to-fuel ratio. An additional 18 percent of vehicles failing were diagnosed as experiencing rich carburetion. These problems are neither difficult nor costly to rectify. Thus, the average repair cost figures may be somewhat misleading. Most vehicles requiring service will experience costs lower than the average reported figure. A small portion will have bills considerably in excess of the average reported figure. If these bills fall into waiver regions (either an absolute dollar limit on repair cost or a percentage of vehicle value figure), then assuming an average repair cost for all failed vehicles can overstate the total repair cost burden to vehicle owners; that is, the total cost of required repairs (those that do not exceed cost limit categories) may be less than the total cost of repairs reported by an I/M sequence.

There are other costs to vehicle owners relating to I/M in addition to repair costs and the vehicle inspection fee. Two major costs to consider are time and operating costs experienced traveling to and from inspection sites. Actual operating costs can be calculated fairly accurately. Time costs have a much more subjective nature.

The vehicle miles traveled (VMT) as a result of an I/M program depend on the size of the affected vehicle population, density of that population, siting of inspection stations, and so forth. A fairly reliable total VMT estimate can be used to determine total vehicle operating costs and time spent on those induced VMT. Applying an average emission level to these extra VMT can provide a rough estimate of emissions induced by the implementation of I/M.

An elusive but probably a more significant figure is the time cost of travel to and from, and waiting time at inspection facilities. There are evaluative decisions about the value of time spent traveling, waiting time, and so on that must be resolved before a dollar figure can be computed. The issue is complicated because different people value their time differently and even value different types of time differently (e.g., time spent driving versus time spent waiting at an inspection site). The value an individual places on his time is related to his income level. As income rises an individual tends to value his time more highly.

Estimating operating and time costs is further complicated because it is difficult to determine what portion of these costs to assign directly to I/M requirements. Many times the trip to an inspection site is combined with other errands and stops. The total costs, time and operating, of such trips should be allocated between the different purposes served by them. It is also difficult to determine how circuitous the I/M stop is. It may require a substantial detour in some cases and none in others.

A potential benefit for the vehicle owner is money saved by utilizing diagnostic information provided by I/M to correct small problems before they become serious. By prompting repairs early on I/M can help eliminate substantial costs to the vehicle owner.

This brief overview of the impacts I/M may have for vehicle owners serves to emphasize the complex nature of program costs and benefits. A qualitative evaluation of them helps assure that they will be considered when implementing I/M.

Impact on the Automotive Repair and Parts Industry

It is safe to state that I/M implementation will result in an increased demand for repair activities and replacement parts. To the extent that I/M induces new repairs that would not have been performed otherwise, the repair industry will directly benefit from the program.

Job creation will be necessary to increase the supply of repair personnel to meet new demand. The ratio of mechanics to vehicles has been declining significantly over the last few decades. In 1950 there were 73 vehicles for every mechanic nationwide. By 1975 this ratio decreased to one mechanic available for every 146 vehicles. This trend cannot continue if I/M becomes a reality. As emissions regulations increase, vehicle complexity will extend repair times for existing components. New subsystems will also be created that will eventually require repair and the demand for mechanic time will increase for each vehicle.

In addition to recruiting and training new mechanics, existing personnel should undergo at least a limited retraining phase to orient them to the purposes and goals of I/M and emissions control. In some cases the needs of I/M are in conflict with maintenance standards now existing that emphasize high engine performance. It is important that the repair industry be aware of the different criteria demanded by I/M so that it may act accordingly.

No matter how responsive the supply of mechanics is to this increase in demand, some lag is inevitable. Because of this, windfall profits may accrue to existing members of the industry for an initial time period. The tight supply situation could result in some overcharging. This should be brief, as new mechanics will be trained and in turn enter the labor pool as the public becomes aware of the implications of I/M. As the supply of repair personnel expands, the consumer will again be able to choose between many repair shops. This will make overpricing practices more difficult. Also, a well supervised maintenance sequence should help deter potentially disruptive behavior by the repair industry,

REFERENCES

1. U.S. Department of Transportation. National Highway Traffic Administration, Traffic Safety Programs. Motor Vehicle Diagnostic Inspection Demonstration Program. Appendix E. Washington, D.C. October 1977.

2. Weiss, D.A., and J. Meteyka. Future Motor Vehicle Inspections Must Offer Better Diagnosis, Automotive Engineering. January 1973.

3. Colorado State University. High Altitude Vehicular Emissions Control Program. Volume II. Experimental Characterization of Vehicular Emissions and Engine Deterioration. Final Report. Prepared for Colorado and the Environmental Protection Agency. August 1976.

4. Vehicle Inspection Program Staff. Bureau of Automotive Repair. California Vehicle Inspection Program Riverside Trail Program Report. Operations from 9/2/75 to 2/13/76. Volume 2 - Summary Report.

5. Hamilton Test Systems. Program Plan for the Implementation of a Motor Vehicle Inspection System. July 1978.

6. Vehicle Inspection Program Staff. Bureau of Automotive Repair. California Vehicle Inspection Program Riverside Trial Program Report. Operations from 9/2/75 to 2/13/76. Volume 2 - Summary Report.

7. The Automobile and the Regulation of its Impact on the Environment. Frank P. Grad et al. University of Oklahoma Press. Norman, Ok. 1975.

SECTION 10

LEGISLATIVE CONSIDERATIONS IN INSPECTION AND MAINTENANCE IMPLEMENTATION

INTRODUCTION

Legislative requirements and potential roadblocks to implementation of one or more alternatives have been researched for the Indiana (I/M) alternatives. The reason for looking at these potential problem areas is to determine, at an early planning/evaluation stage, if there are any legal, legislative or other issues related to any alternative under consideration which could potentially hinder its acceptance by the state legislature.

METHODOLOGY

The methodology used to research this area consisted of two stages. In the first stage the alternatives themselves were studied in detail to determine what, if any, legal, organizational, or institutional conflicts, or problems exist. Also, model legislation provided by the U.S. EPA was studied. The U.S. EPA was also consulted to determine if they had uncovered problem areas which should be researched further. The second phase consisted of studies of existing states' experience in I/M. Enabling legislation from several states was studied. Directors and staff members were asked to comment on particular problems they had encountered.

Because the state legislature was not consulted at this early planning stage, it would not be expected to provide appropriate comments on the alternatives. At a later stage in the development of the I/M program, the legislature will become more directly involved and will presumably draft enabling legislation that minimizes potential problem areas.

POSSIBLE POLITICAL CONSTRAINTS

While the technical feasibility of I/M has been proven, many jurisdictions have experienced difficult problems enacting legislation. Program implementation has often been hindered by substantial secondary program impacts. While I/M is designed to help realize certain ambient air quality standards, it also produces significant political, social and institutional impacts.

These indirect program impacts are discussed in Section 9. They illustrate the wide scope of the impact an I/M program has on the citizenry at large. Some of these impacts carry political implications that require consideration when I/M enabling legislation is passed. Among others, the following impacts are pertinent:

- Impact on low income citizens
- Impact on the automotive repair and parts industry
- Potential overcharging for repairs and performance of unnecessary repair work
- General inconvenience of I/M compliance to the general public.

Legislatures are quick to recognize how I/M programs directly affect the public. They realize that a few complaints about the program can result in widespread public attention by the press and various interest groups that are adversely affected by program implementation. These impacts must be carefully considered during the early phases of selecting an alternative.

A major argument likely to be made by consumer protection groups and legal aid societies, etc. is that low income citizens will be denied the right to operate an old vehicle because the cost of maintaining that vehicle's emissions level to I/M standards is prohibitive. This argument attacks the concept of imposing a mandatory maintenance scheme and will likely be made regardless of the alternative ultimately chosen.

A properly designed I/M program can take this issue into account and establish certain criteria to exempt just this type of vehicle from the mandatory maintenance phase. This makes the potentially regressive nature of the program more tolerable. There are several types of compliance exemptions. A ceiling can be placed on repair costs that is based on either an absolute dollar figure or a percentage of vehicle value, whichever is lower.

This approach would mandate that a maximum dollar figure be spent regardless of whether or not the repair results in lower emissions. If the repair necessary for emissions compliance costs more than the ceiling placed on repairs, a substantial sum may be spent without any real result. Though as yet untried, a potential answer to this problem exists: vehicles over a certain age are usually granted exemptions, but maximum charges could be established as well for each aspect of diagnosis, parts replacement, adjustment, etc.

These exemptions will not have a significant effect on the ability of an I/M program to achieve a reduction in total vehicle emissions. A majority of the vehicles that are seriously out of compliance and costly to repair are older vehicles. Since they will not remain roadworthy for long periods of time, they will tend to be quickly eliminated from the total vehicle population. The vehicles that filter down to replace these gross emitters will have been kept in compliance as a result of I/M and should be relatively inexpensive to maintain over time. Also, it is likely that public transportation will capture more low income groups as well as attracting the general public, thereby reducing overall VMTs.

The automotive parts and service industry has a lobby that must be considered when designing a program. Members of the industry will want to know how I/M will affect their clientele; that is, how their ability to maintain vehicle performance standards that customers are unfamiliar with will be received. There are likely to be doubts concerning not only this, but the accuracy of HC/CO analyzers and the ability of certified state inspection stations to profitable finance the program's equipment requirements.

In addition, several alternatives propose shifting the existing safety inspections from certified state inspection stations to contractor facilities (alternative 4 and potentially alternatives 3, 5 and 6). Since the safety inspections program is already in place, the repair industry has the capacity to handle the demand. If existing safety inspections are shifted to contractor facilities, the repair industry is likely to experience excess capacity and a loss in income. It will certainly experience a lower level of customer service. It is quite likely that the industry will react unfavorably to the removal of existing safety inspections from their control.

Need for Public Information Program

Many of the questions raised by I/M can be properly answered with a vigorous public information campaign (see Appendix C). A well designed public information program can gain public acceptance for I/M and relieve the public's fears of price gouging, varying program effectiveness, etc. Legislators are liable to be sensitive to problems similar to those that have been experienced in safety inspection programs. The intangible nature of program benefits allows costs to be overemphasized. However, emphasizing the checks and balances built into the program (i.e., quality assurance through equipment inspection and calibration schedules) and while not readily visible, potential health benefits accruing from pollution emission reductions, will help to facilitate the implementation procedure.

A public information program can address other benefits to the vehicle owner. Improvements in fuel economy and the impact I/M has on vehicle performance and longevity are good points to stress. Control of offensive vehicles that emit high quantities of visible smoke and assurances that all vehicles will be tested and certified to comply with clean air requirements are also important elements. If the preconceptions held by the public and the repair industry can be successfully altered by a public information program, it will have gone a long way towards easing the legislative problems standing between a proposal for I/M and its final implementation.

POTENTIAL ALTERNATIVE-SPECIFIC ISSUES

The differences that distinguish the various alternatives themselves raise the possibility of legislative roadblocks to implementation occurring. Identifying such potential areas of friction at an early stage in the planning process is important. Proper consideration of these distinctions when drafting and enacting I/M enabling legislation should greatly reduce alternative-specific legislative problems.

Designated Lead Agency

Not all variations between alternatives affect the likelihood of incurring implementation problems. A substantial difference in designated lead and administrative agencies from alternative to alternative could have an impact on the viability of certain alternatives. All six alternatives designate the Indiana Air Pollution Control Board as the lead administrative agency. The state might also want to consider a cooperative role in administration with the Bureau of Motor Vehicles, state and local police agencies, etc.

Geographic Coverage

The six I/M program alternatives studied vary widely in overall geographic coverage. For alternatives 2, 3, and 4, emissions tests will be conducted in the 7 urbanized counties (Allen, Clark, Floyd, Lake, Marion, Porter, and St. Joseph). For alternative 5, coverage will include these seven urbanized counties plus those portions of the South Bend and Indianapolis urban areas which are located in Elkhart, Hamilton, and Johnson Counties. For alternatives 1 and 6, coverage will be statewide.

The U.S. EPA has issued several policy statements regarding the geographic scope of I/M programs. The original statement, contained in sample I/M legislation, specifies program applicability to all registered light duty vehicles (LDV) in certain Air Quality Control Regions (AQCR) in which National Ambient Air Quality Standards (NAAQS) for HC, CO, or O_x are exceeded. Because their boundaries frequently cross state lines, however, AQCRs are rather impractical as administrative jurisdictions for I/M programs to be implemented by the states. Recognizing this, the EPA modified its position in the criteria for approval for 1979 State Implementation Plan (SIP) revisions for nonattainment areas. These criteria provide more freedom in establishing the geographic scope of an I/M program by allowing "a certain degree of flexibility" in drawing the specific boundaries of major urban areas, which are defined as having an urbanized population of 200,000 or greater. The most recent U.S. EPA policy statement on I/M programs, dated July 17, 1978, states:

> I/M should focus on metropolitan areas and should include the entire urbanized area and adjacent fringe areas of development. Boundaries of the area affected may be adjusted if an equivalent emissions reduction is achieved....Statewide programs are encouraged, especially for those states which are small and highly urbanized.

The above statement indicates that alternatives 1, 2, 3, 4, and 6 should have no difficulty meeting Federal approval. For alternative 5, however, the "adjacent fringe areas of development" have not been included for Elkhart, Hamilton, and Johnson counties, leaving the specific legality of its boundary definition somewhat in doubt. At the state level, there appear to be no legal constraints regarding the establishment of the geographic scope of an I/M program. Thus, with the possible exception of alternative 5, differences in geographic coverage between alternatives are not affected in an alternative-specific manner by Federal or state authority.

Administration

As discussed above, it appears unlikely that the overall geographic coverage of each of the six program alternatives studied will encounter legal difficulties. The manner in which the responsibility for performing I/M functions is divided between contractor-operated facilities and certified state inspection stations (CSIS) in alternatives 5 and 6, however, may well create administrative problems of such consequence that legislative acceptance of these alternatives is uncertain.

In these two alternatives, contractor-operated inspection facilities will service that portion of the LDV population which falls within the boundaries of the 5 urbanized areas (Gary, South Bend, Fort Wayne, Indianapolis, and Louisville). In alternative 5, certified state inspection stations will perform emissions inspections only in the rural portions of Lake, Porter, St. Joseph, Allen, Clark and Floyd counties. In alternative 6, certified state inspection stations will conduct emissions inspections in all areas of the state outside the 5 urbanized areas.

It should be emphasized that the boundaries of the 5 urbanized areas have been drawn by their metropolitan planning organizations largely for areawide transportation planning purposes. These boundaries do not, in general, coincide with those of local political jurisdictions. Because they are likely to change over time, they are not used for administrative pusposes. The public generally understands that city limits and county lines relate to governmental jurisdictions; explaining an entirely new set of boundaries to the average citizen may well be difficult, especially when the urban-rural designation involves concepts with which he is not likely to be familiar. This problem is particularly acute in alternative 5, where residents of those portions of Elkhart, Hamilton, and Johnson counties covered by the I/M program are liable to question the partial coverage of their counties.

The urban-rural division of alternatives 5 and 6 also creates the administrative problem of defining exactly which motor vehicles are "rural" and which are "urban." It would be inappropriate to use postal addresses for this purpose. Many households use post office boxes outside their local neighborhoods as mailing addresses, and the boundaries defining rural delivery routes and rural zip code areas are not the same as those used to define I/M coverage areas.

Enforcement

Aside from the administrative problems described above, it is likely that alternatives 5 and 6 will encounter difficulties in enforcement. In order to ascertain that urban vehicles are inspected in urban facilities and rural vehicles are inspected in rural facilities, operators of both types of facilities must have access to lists of all vehicles registered in the urban and rural areas. The Indiana Bureau of Motor Vehicles presently collects and records all registration data on a county-by-county basis; thus, present registration policies must be changed or vehicle owners will be able to cross the I/M jurisdictional lines undetected. This problem will be especially acute for alternative 5 in the three counties that are only partially covered.

Certified State Inspection Stations

It should be recognized that any alternatives which utilize certified state inspection stations (CSIS) may also encounter legislative problems. This is for two reasons: one is that there is more difficulty in keeping the certified state inspection station analyzers in calibration than the contractor facility analyzers. Hence, there are serious quality assurance problems in utilizing certified state inspection stations, although with proper controls, this situation can be somewhat improved. The second reason has to do with the conflict of interest inherent in having the same certified state inspection station do the testing, on the one hand, and on the other hand, perform the required maintenance. The automobile repair industry is currently under attack from consumer groups. The fact that there have been maintenance difficulties with emission equipment in new cars simply adds to this problem as there is a long time lag between the manufacture of the cars with more complex emission controls and the automobile service industry's learning all the new procedures needed for adequate repair of emission controls and retraining for routine maintenance which becomes more complicated as the controls are added.

Licensing Problems

The alternatives may encounter licensing problems. Both facility types, contractor and certified state inspection stations, are subject to EPA licensing requirements. An EPA-approved training and certification program for mechanics must be established by the state for both these approaches. A certified state inspection station must have a licensed mechanic present in order to be thus certified as an I/M inspection station. Facilities operated by private contractors must also have certified personnel on hand.

At this point, EPA officials have declined to elaborate on licensing requirements and procedures pending the release of a position paper that will deal explicitly with these issues. The licensing procedure should consist of similar requirements for the contractor and certified state inspection stations. There should be no problem from the state viewpoint regarding a licensing procedure of the type the EPA is contemplating.

The certified state inspection station approach incurs higher quality control costs because more facilities must be licensed and federally required monthly inspections of equipment in those facilities will be more costly than for centralized I/M lanes.

Personnel Requirements

State administrative requirements will be similar for all alternatives with the exception that there will be more emissions analyzers spread out among the certified state inspection stations than there will be in a contractor approach. This equipment would require a substantial manpower commitment by the state in the form of state investigators. They would inspect and calibrate the analyzers on a monthly basis. Since a contractor often computerizes analyzer calibrations, many more investigators would be needed in the certified state inspection station approach than in the contractor approach. Also, for purposes of comparison in this report, the state level of administration for alternatives 1, 2, 5 and 6 is defined as a minimum to be developed in more detail once more policy decisions are made in a later phase.

Funding

A final consideration that may have alternative-specific implications is that different types of funding are required for various alternatives. The availability of funding for capital expenditures versus operating and administrative costs may have a significant impact on the probability of implementing certain alternatives. Consideration may be given to leasing state-owned facilities to contractors to ease adverse affects that funding problems may cause.

CONCLUDING REMARKS

For the most part, legislative problems are likely to be political in origin. There are no purely legal federal or state roadblocks to any of the alternatives presented. Rather, the nonlegal ramifications of the various alternatives are more pertinent.

While it would be ideal if all potential problems could be anticipated when enacting I/M legislation, it is unlikely that all such difficulties can be taken into account. The enabling legislation should be flexible enough to allow a degree of discretion for the administrative agencies involved. Leeway on quality controls, cut points, etc. should improve program effectiveness considerably. Building such discretion into regulatory authority should shorten lead times and prove to be cost effective, as well as adding to program flexibility.

SECTION 11

COMPARATIVE EVALUATION OF ALTERNATIVES AND REFERENCE MATRIX

This report evaluates six proposed vehicle inspection and maintenance programs (I/M) in the State of Indiana. The proposed programs, or alternatives, are discussed individually in Sections 3 through 8. The methods used in analyzing these alternatives are developed in Section 2. This section focuses on summarizing the detailed findings of these previous sections, and therefore does not contain a complete description of each alternative. A reference table (Table 109) is provided, which indicates those pages in Sections 2 through 8 where certain key topics are discussed in detail.

COMPARISON OF COSTS BY ALTERNATIVE

For the alternatives analyzed in this report, emissions inspections are performed by either a contractor or certified state inspection stations (CSIS). In alternative 3, a contractor provides emissions inspections in the seven nonattainment counties of Allen, Clark, Floyd, Lake, Marion, Porter, and St. Joseph; in alternative 4, a contractor provides safety as well as emissions inspections in the same seven-county region; and in alternatives 5 and 6, a contractor provides emission inspection in five urbanized areas (Gary, Ft. Wayne, Indianapolis, Louisville and South Bend). Columns 3, 4, and 5 of Table 110 summarize the annual costs of these contractor services and the fees charged per inspection.

CSIS performed emissions inspections are included in alternatives 1, 2, 5, and 6. In alternative 1, CSIS emissions inspections are performed statewide; and in alternative 2, CSIS emissions inspections are performed in the seven-county region. In alternatives 5 and 6, the CSIS network extends I/M program coverage beyond the five urbanized areas in which contractor-run emissions inspections are performed. In alternative 5, certified state inspection stations perform emissions inspections in those portions of the seven counties not included in the five urbanized areas; and in alternative 6, CSIS emissions inspections are performed in all parts of the state outside the five urbanized areas.

There are two types of costs to the motorist associated with CSIS performed emissions inspections. First, there is the actual inspection cost incurred by the CSIS. These figures are reported in Table 111. In addition, the state must maintain a network of surveillance and calibration vans to assure quality control in accordance with EPA requirements. The annual cost per inspection of this network (called the emission sticker fee) is included in Table 110.

TABLE 109. REFERENCE MATRIX FOR INFORMATION ON EACH INDIANA I/M ALTERNATIVE BY PAGE NUMBER

Program element	Methodologies discussion	Reference matrix for information on each Indiana I/M alternative by page number						
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5 (five urbanized areas)	Alternative 5 (Nonurbanized areas of seven counties	Alternative 6
Network Requirements	17, 37 Appendix G	46	55, 56	65, 66	88-90	116	135	148-150 168-170
Costs								
Initial Capital Costs	19-23	47-48	58-59	65, 67-72	91-97	116-118 120, 121	136-137	149, 151-156
• land								
• buildings								
• equipment								
One-Time Startup Costs	23-29 Appendix C	48	61	67, 73-76	91 98-101	118, 119 122, 123	136-139	152, 157-159
• land acquisition								
• facilities planning								
• program design								
• data-handling software								
• personnel training								
• personnel salaries								
• public information program								
Annual Operating Costs	29, 30	50-51	60-61	76-81	100 102-105	123-129	141-142	158, 160-163
• facility personnel								
• maintenance								
• calibration costs								
• utilities/services/supplies								
Annual Administrative Costs	30	49-51	59-61	78, 81	105, 106	127, 130	140	161, 164
Cost Summary	-	52	62	82	107, 108	131	139	165, 166
Personnel Requirements	31-36	201	201	73, 76, 201	99, 201	201	201	157, 201
Consumer Protection Mechanisms	-	46-47	57	77	103	127	135, 136	170
Enforcement Considerations	-	31, 47	31, 57	31	31	31	31, 135, 136	31, 170
Quality Assurance Requirements	-	46, 47	57	76, 77	102, 103	122-123	135, 136	170, 171
Legislative Considerations	Section 10	49, 52, 190	61, 62 189, 190	83, 85 188-190	111 188-190	133,144 188-191	133, 144 188-191	173, 188 190, 191
Benefits	-							
• emissions reductions	37	53	63	85, 86	112, 112	147, 148	146, 147	177, 178
• fuel savings	Appendices A and B							
• vehicle life and performance								
Possible Externalities	Section 9	48	62	83, 85	111	133, 144	133, 144	173

Reproduced from best available copy.

TABLE 110. SUMMARY OF ANNUAL STATE AND CONTRACTOR COSTS AND FEES (1978 DOLLARS)

Annualized costs	Alternative 1 emissions sticker fee (statewide)	Alternative 2 emissions sticker fee (7 counties)	Alternative 3 contractor's fee (7 counties)	Alternative 4 contractor's fee (7 counties)	Alternatives 5 and 6 contractor's fee (5 urbanized areas)	Alternative 5 emissions sticker fee (nonurbanized portions of 7 counties)	Alternative 6 emissions sticke. fee (part of state not in urbanized areas)
With i = 0.03*							
I. Annualized Capital Costs							
1. Land	-	-	101,000	216,000	99,000	-	-
2. Buildings	-	-	577,000	1,231,000	564,000	-	-
3. Equipment	196,000	71,000	693,000	2,438,000	681,000	15,000	136,000
II. Annualized Startup Costs	715,000	262,000	711,000	1,162,000	728,000	56,000	497,000
III. Annual Operating Costs	3,001,000	1,084,000	4,395,000	16,784,000	4,281,000	230,000	2,087,000
IV. Annual Administrative Costs	107,000	107,000	1,044,000	948,000	1,015,000	-	-
Total Annual Cost	4,020,000	1,525,000	7,425,000	22,779,000	7,368,613	301,000	2,719,000
Fee f_c With Paid Emissions Retest	0.66	0.63	3.05	9.37	3.22	1.03	0.72
Fee f_c With Free Emissions Retest	0.86	0.82	3.96	12.18	4.19	1.34	0.93
With i = 0.06*							
I. Annualized Capital Costs							
1. Land	-	-	203,000	433,000	198,000	-	-
2. Buildings	-	-	749,000	1,598,000	733,000	-	-
3. Equipment	213,000	77,000	754,000	2,650,000	741,000	16,000	148,000
II. Annualized Startup Costs	777,000	285,000	775,000	1,264,000	792,000	61,000	540,000
III. Annual Operating Costs	3,001,000	1,084,000	4,395,000	16,784,000	4,281,000	230,000	2,087,000
IV. Annual Administrative Costs	107,000	107,000	1,053,000	948,000	1,015,000	-	-
Total Annual Cost	4,099,000	1,554,000	7,820,000	23,676,000	7,759,000	307,000	2,774,000
Fee f_c With Paid Emissions Retest	0.67	0.64	3.22	9.74	3.39	1.05	0.73
Fee f_c With Free Emissions Retest	0.87	0.83	4.19	12.66	4.41	1.37	0.95

*i = interest rate in absence of inflation.

TABLE 111. SUMMARY OF CSIS FEES (1978 DOLLARS)

	Alternative 1 (statewide) ($)	Alternative 2 (7 counties) ($)	Alternative 5 (7 counties not in U.A.) ($)	Alternative 6 (part of state not in U.A.) ($)
Safety	4.00 + 0.50*	4.00 + 0.50*	4.00 + 0.50*	4.00 + 0.50*
Emissions				
With paid emissions retest	2.38	2.15	2.03	2.48
With free emissions retest	3.09	2.80	2.63	3.22
Total-Safety and Emissions				
With paid emissions retest	6.88	6.65	6.53	6.98
With free emissions retest	7.59	7.30	7.13	7.72

*CSIS safety inspection includes free reinspection per current policy. Costs are $4.00 for the CSIS plus $0.50 for the safety sticker.

The current CSIS safety inspection program will continue in all alternatives with the exception of alternative 4. In alternative 4, a contractor will perform safety inspections in the seven-county region, while the CSIS network will continue to perform safety inspections in the remainder of the state. For comparative purposes, costs are included for CSIS safety inspection. These costs are $4.00 for the CSIS (15 minutes at $16.00 per hour) plus $0.50 for the safety sticker fee.

Figures 10 and 11 report all the above costs for $i = 0.03$ and 0.06. For each alternative, the total cost per inspection with free reinspection is presented for each geographic area of program coverage. These fees, along with all other figures in this section, are in 1978 dollars. Hence, for any year after 1978, all amounts must increase at the same rate as inflation.

COMPARISON OF EMISSION REDUCTION BENEFITS

The extent of emission reductions resulting from I/M depends upon the number of vehicles in Indiana subject to mandatory emissions inspection. In alternatives 2, 3, and 4, only those vehicles registered in the seven-county region are subject to emissions inspection. In addition to the seven-county region, alternative 5 has mandatory inspection in that part of Elkhart County contained in the South Bend urbanized area and in those parts of Hamilton and Johnson Counties contained in the Indianapolis urbanized area. For alternatives 1 and 6 emissions inspection is statewide. The emissions reductions that correspond to these three geographic coverages are reported in Table 112.

COMPARISON OF PERSONNEL REQUIREMENTS

Table 113 summarizes the personnel requirements associated with the six alternatives analyzed in this report. In addition to personnel directly involved in administration and contractor operations, the mechanics required by the CSIS network are also included for the appropriate alternatives.

POSSIBLE EXTERNALITIES AND LEGISLATIVE CONSIDERATIONS

At this stage it is difficult to make comparisons between the various alternatives with regard to their externalities (or indirect impacts) or potential legislative, legal, or political roadblocks. As discussed in Section 9, "Possible Externalities: Indirect Impacts," most of these external or indirect impacts are neither easily quantified nor alternative specific. Much of the available data pertaining to them is either incomplete or inconclusive, and they tend to occur more as a result of I/M in general than as a result of implementing any particular alternative.

In Section 10, "Legislative Considerations in Inspection and Maintenance Implementation," potential roadblocks to I/M implementation are discussed entirely apart from involvement by the Indiana State Legislature. Certain perspectives are offered concerning potential political, social and institutional impacts. These are based upon evaluation of the Indiana alternatives themselves and other states' experience. During the next phase, when the state legislature becomes more involved, more pertinent issues will become apparent.

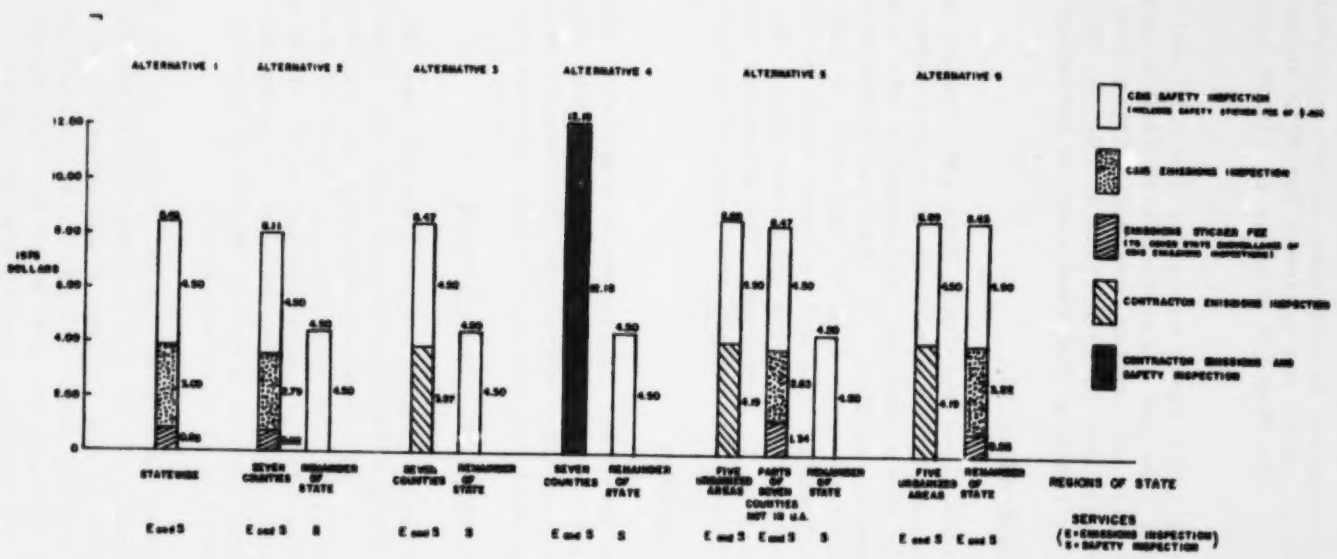


Figure 10. Summary of fees with free reinspection and i = 0.03 (i = interest rate in absence of inflation).

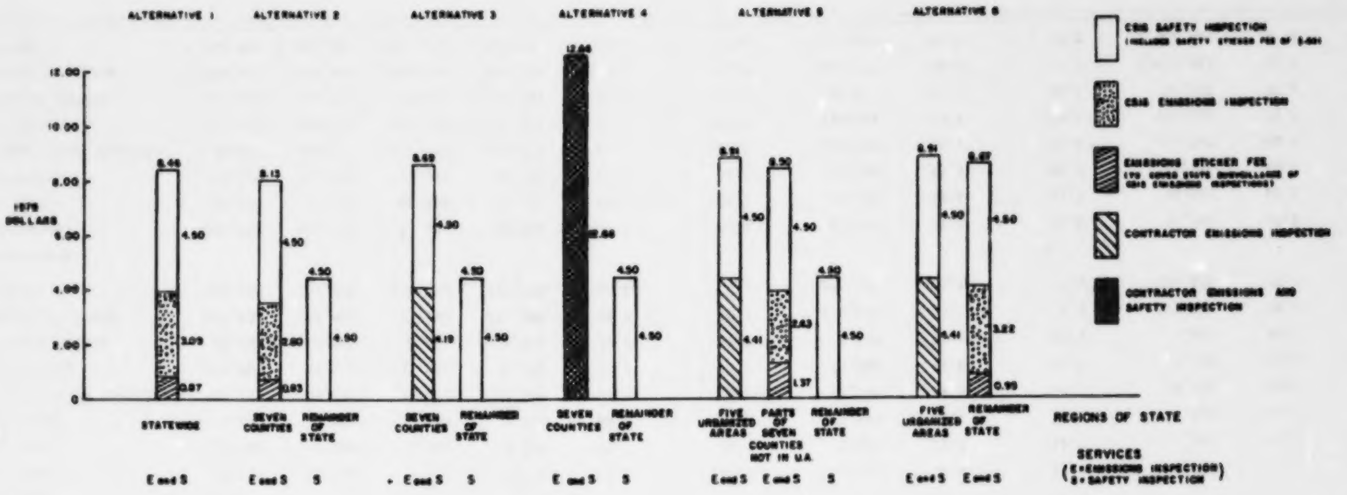


Figure 11. Summary of fees with free reinspection and i = 0.06 (i = interest rate in absence of inflation).

TABLE 112. SUMMARY OF HYDROCARBON AND CARBON MONOXIDE EMISSIONS (kg/day)

Area	1975	1982	1987 Without I/M	Alternatives 2, 3, 4			Alternative 5			Alternatives 1, 6		
				1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M	1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M	1987 With I/M	Percent reduction 1977 to 1987 with I/M	Percent reduction 1987 without I/M to 1987 with I/M
Hydrocarbons												
Allen County	28,011	15,508	9,055	6,612	76.4	27.0	6,612	76.4	27.0	6,419	77.1	29.1
Clark County	13,368	7,805	4,721	3,649	72.7	22.7	3,649	72.7	22.7	3,567	73.3	24.4
Floyd County	5,272	3,362	2,207	1,650	68.7	25,2	1,650	68.7	25.2	1,622	69.2	26.5
Lake and Porter Counties	60,298	38,878	24,122	19,249	68.1	20.2	19,249	68.1	20.2	19,145	68.2	20.6
Marion County	102,962	59,941	36,949	28,195	72.6	23.6	27,980	72.8	24.2	27,169	73.6	26.5
St. Joseph County	29,827	15,260	8,467	6,025	79.8	28.8	5,673	81.0	33.0	5,929	80.1	29.9
Remainder of State	563,932	362,616	233,198	231,628	58.9	0.7	230,229	59.2	1.3	171,004	69.7	22.3
Statewide	803,670	503,370	318,720	297,008	63.0	6.8	295,042	63.3	7.4	234,855	70.7	26.3
Carbon Monoxide												
Allen County	205,691	144,588	88,489	56,992	72.3	35.6	56,992	72.3	35.6	54,509	73.5	38.4
Clark County	100,270	71,335	46,469	31,735	68.4	31.7	31,735	68.4	31.7	30,625	69.5	34.1
Floyd County	40,819	31,354	21,671	14,146	65.3	34.7	14,146	65.3	34.7	13,756	66.9	36.5
Lake and Porter Counties	592,067	460,323	277,799	212,658	64.1	23,4	212,658	64.1	23.4	211,255	64.3	24.0
Marion County	877,261	609,294	361,721	258,861	70.5	28.4	258,861	70.5	28.4	246,414	71.9	31.9
St. Joseph County	231,206	149,915	80,563	53,251	76.9	33.9	52,688	77.2	34.6	52,177	77.4	35.2
Remainder of State	3,860,327	3,354,665	2,484,718	2,465,019	36.1	0.8	2,446,771	36.6	1.5	1,673,513	56.7	32.6
Statewide	5,908,000	4,820,480	3,361,430	3,092,662	47.6	8.0	3,073,851	48.0	8.6	2,282,249	61.4	32.1

TABLE 113. SUMMARY OF MANPOWER REQUIREMENTS (ANNUAL MAN-YEARS)

Level of employment	Alternative					
	1	2	3	4	5	6
Administrative[*]	6	6	13	13	13	13
Regional administrative[*]	-	-	20	20	24	24
Contractor facility personnel	-	-	220	987	214	214
CSIS quality assurance personnel	124	46	-	-	10	86
Total direct program personnel	130	52	253	1,020	261	337
(CSIS mechanics) emissions[†]	254	101	-	-	13	159
(CSIS mechanics) safety[‡]	761	761	761	457	761	761
Total direct and indirect personnel	1,145	914	1,014	1,477	1,035	1,257

[*] For alternatives 1 and 2, a minimum number of state administrative personnel (APCD) are included. It is assumed here for comparison that existing safety program administrative personnel will oversee the I/M program.

[†] Assumes a mechanic works 2000 hours per year.

[‡] Personnel performing the current CSIS safety inspections (761) are already in place. This figure is presented to illustrate the impacts on personnel requirements that result when safety inspections are shifted to a contractor-run facility in alternative 4.

A description of differential aspects of external impacts and political or legal roadblocks, however, may at least serve to clarify which portions of the Indiana population are affected most by the external costs and benefits associated with each alternative. If legislation for program implementation is designed to minimize these impacts, public support of I/M is likely to be much greater than otherwise. The discussion below will therefore identify key elements among the external impacts and legislative considerations which can be linked to specific alternatives.

Fuel Savings

To date, no conclusive evidence exists regarding the magnitude of fuel savings that results from implementation of an I/M program. It is generally assumed that I/M results in slightly less overall fuel consumption. A 7 percent improvement in fuel economy for vehicles requiring maintenance by I/M program standards is a standard figure on which to base approximate calculations. If 30 percent of the vehicle population undergoes mandatory repairs, the average increase in fuel economy over the entire vehicle population will be 2.1 percent of total fuel consumption.

As explained in Appendix B, the total level of fuel savings depends upon the geographic coverage or the size of the motor vehicle population covered by a particular I/M alternative. Alternatives 1 and 6 cover the entire state. All light-duty vehicles in Indiana will be subject to I/M, so the largest possible fuel savings will result. Alternatives 2, 3 and 4 cover the smallest geographic areas and the smallest vehicle populations, so total fuel savings would be the smallest for these alternatives. Alternative 5 falls between these two extremes.

Appendix B contains a detailed description of how fuel savings are calculated. Table B-1 presents fuel saved in gallons per day for a range of fuel economy improvements. Calculations were not performed for alternative 5 because vehicle miles traveled (VMT) figures are not available on an urbanized-rural basis.

Impact on Vehicle Performance and Vehicle Life

Studies of the effects of I/M programs on vehicle performance and vehicle life are not definitive, as these impacts are inherently difficult to quantify. Overall degradation in motor vehicle performance and shortrun vehicle deterioration after maintenance can be expressed as nonlinear relationships over time. As yet, however, no studies conclusively corroborate the commonsense notion that I/M should have a positive impact on vehicle performance and life.

Alternatives 1 and 6 both provide statewide geographic coverage and should bring about the largest positive impacts. Alternatives 2, 3 and 4 should realize the least improvement in overall vehicle performance and life, while alternative 5 probably falls somewhere between the two extremes.

Impact of Required Maintenance Costs

Costs of repairs for failed vehicles will be borne by motor vehicle owners in all six alternatives. On an average, these costs are not likely to be excessive. Establishing a ceiling on repair costs at the onset of the program, however, successfully eliminates the possibility of mechanics charging excessive amounts for I/M repairs. Other types of compliance exemptions for older vehicles or those incurring prohibitive repair costs may also be considered to safeguard owners and guard against the adverse effects of program implementation.

Time Costs of Traveling to and From the Inspection Site

The amount of time the average motorist spends traveling to and from an inspection station depends upon the number of inspection sites and whether safety and emission inspections are performed in the same facilities. Certified State Inspection Stations (CSIS) are more numerous and hence more accessible than centralized contractor facilities. However, a trade-off is involved. CSIS inspections generally take longer than contractor performed inspections. If the residence time (the length of time of the average CSIS conducted inspection) can be kept to a minimum, then the timesaving associated with CSIS emissions inspection will be greater than those associated with contractor-operated networks.

Alternatives 1, 2 and 4 all require vehicle owners to make one stop for inspection purposes. On the other hand, some geographic areas in alternatives 3, 5 and 6 require two stops - one for emissions inspection and another for a safety inspection. These "two step" alternatives require more travel time than under alternatives 1, 2 and 4, which the average motorist may perceive as an inconvenience.

Impact of Unscrupulous Repair Practices

Implementation of an inspection/maintenance program, while producing significant air quality and public health benefits, also unfortunately raises the possibility that unsuspecting motorists will be overcharged for repairs or have their vehicles overrepaired by unscrupulous businesses. This problem is heightened due to the fact that it is impossible to tell from outward appearances or performance whether or not a vehicle's emissions control systems are functioning properly; the only true test of emissions levels involves the use of an infrared HC/CO analyzer, a delicate instrument which requires frequent calibration. Failure of an emissions test in most cases does not imply the need for a complete tuneup; the average motorist, however, is not likely to be so familiar with emissions control techniques as to know exactly what type of maintenance is required.

Because certified state inspection stations have both the capabilities to inspect vehicles and to repair them, the risk of overcharging and overrepair is greatest in those alternatives involving CSIS inspections (alternatives 1, 2, 5 and 6). To the extent that vehicles failed in contractor-operated facilities must also undergo maintenance in privately-owned repair facilities, alternatives 3 and 4 are also subject to this problem. Setting maximum allowable repair charges, licensing mechanics and/or repair facilities and providing diagnostic information to the owner of a failed vehicle are three possible solutions.

Impact on Low Income Citizens

Adverse public reaction to I/M may be generated by the manner in which it affects low income groups. The major argument states that this group is likely to be denied the right to operate an older vehicle because of prohibitive I/M maintenance costs. This argument can be applied to all six alternatives and solved for all six alternatives by establishing certain exemption criteria. Moreover, a vigorous public information campaign could address such questions raised by the public about I/M.

Impact on the Motor Vehicle Repair and Parts Industry

To the extent that implementation of an inspection/maintenance program causes vehicle owners to have their vehicles repaired more often than they would otherwise, the motor vehicle repair and parts industry will experience an increase in total income as a result of I/M. The magnitude of this increase is dependent on the average vehicle maintenance habits of the motoring public, and is therefore very difficult to quantify.

Impacts on Repair Industry Employment

There are two aspects to consider here. First, CSIS mechanics trained in emissions inspection and maintenance techniques will be required for alternatives 1, 2, 5, and 6. Second, each CSIS will have to devote on the average one-third more time (or 1/2 hour) to performing combined emissions and safety inspections over that already spent performing safety inspections. How this additional time requirement will affect the CSIS network is important. For alternatives 1, 2 and 6 it is unlikely that this impact would be regarded as an excessive burden. However, for alternative 5, some portions of the projected CSIS network will be required to spend 4 more hours per day performing combined inspections. In these areas it is likely that more certified mechanics will be needed.

To the extent that I/M increases the total workload, employment in both the repair and parts industry will rise. The magnitude of these increases is likely to rise in direct proportion to the size of the I/M vehicle population tested. Alternatives 1 and 6 should generate the largest increases in employment, alternatives 2, 3 and 4 will increase employment the least, and the impact of alternative 5 will be moderate.

APPENDIX A

DETAILED DESCRIPTION OF METHODOLOGY FOR CALCULATING EMISSION INVENTORIES

Emission inventories are calculated for eight geographic areas: Allen County, Clark County, Floyd County, Lake and Porter Counties, Marion County, St. Joseph County, the remaining 85 counties, and the total state. For each area, both hydrocarbon and carbon monoxide inventories are reported for 1975, 1982, and 1987. For 1987, inventories are calculated without an I/M program as well as with I/M programs that correspond to the various alternatives analyzed in this report.

Several agencies provided the data used in calculating these emissions inventories. The Kentuckiana Regional Planning and Development Agency provided data for Clark and Floyd Counties (Table 114 and Table 115); the City of Indianapolis, Department of Metropolitan Development provided data for Marion County (Table 116); Pacific Environmental Services, Inc. provided data for Allen, Lake, Porter and St. Joseph Counties (Table 117, Table 118, and Table 119); and the Indiana Highway Commission, Office of Highway Development provided statewide data (Table 120). Whenever possible, the local data supplied by these sources were used in lieu of national (default) values supplied by U.S. EPA in Mobile I.[1]

Pacific Environmental Services, Inc. (PES), under contract with U.S. EPA Region V, has also calculated mobile source inventories for Allen, Lake, Porter, and St. Joseph Counties. In an attempt to provide compatible emissions inventories for these counties, the assumptions employed by PES are used when calculating inventories for these areas.

Emission inventories are calculated using U.S. EPA's Mobile I computer program. The Mobile I routine is based upon vehicle-specific emission factors calculated for vehicles by operating them through EPA's Federal Test Procedure (FTP) - urban driving cycle. The program contains tables of emission levels for each model year vehicle from 1951 to 1990 for vehicle ages between 0 and 20 years old. Separate tables are used for light-duty vehicles (LDV), light-duty truck 1 (under 6,000 lb gross weight - LDT1), light-duty truck 2 (between 6,000 lb and 8,500 lb gross weight - LDT2), heavy-duty diesel (HDD), heavy-duty gasoline (HDG), and motorcycles (MC). Separate tables are also given for three geographic regions: California, high-altitude areas, and the rest of the United States. The latter tables are used for Indiana.

Since the basic emission factors are FTP specific, adjustments must be made to reflect actual local driving patterns. Mobile I contains

TABLE 114. DATA FOR CLARK COUNTY

	1975				1982				1987			
	Freeway	Arterial	Local	Total	Freeway	Arterial	Local	Total	Freeway	Arterial	Local	Total
Speed	54	35	25		54	35	25		54	35	25	
Cold starts - LDV (%)	10	25	40		10	25	40		10	25	40	
Hot starts - LDV (%)	0	25	20		0	25	20		0	25	20	
Stabilized - LDV (%)	90	50	40		90	50	40		90	50	40	
Daily VMT												
LDV	547,000	488,000	398,000	1,433,000	637,000	565,000	416,000	1,618,000	727,000	571,000	447,000	1,745,000
LDT_1	93,200	83,900	68,300	245,400	109,000	96,300	71,400	276,700	124,000	96,300	74,500	294,800
LDT_2	37,300	34,200	24,800	96,300	43,500	37,300	27,900	108,700	49,700	37,300	31,100	118,100
HDG	9,300	9,300	6,200	24,800	9,300	9,300	6,200	24,800	12,400	9,300	6,200	27,900
HDD	59,000	77,600	68,300	204,900	106,000	96,300	68,300	270,600	121,000	96,300	74,500	291,800
Total	745,800	693,000	565,600	2,004,400	904,800	804,200	589,800	2,298,800	1,034,100	810,200	633,300	2,477,600

Source: Kentuckiana Regional Planning and Development Agency, Louisville, Kentucky.

TABLE 115. DATA FOR FLOYD COUNTY

	1975				1982				1987			
	Freeway	Arterial	Local	Total	Freeway	Arterial	Local	Total	Freeway	Arterial	Local	Total
Speed	54	35	25		54	35	25		54	35	25	
Cold starts - LDV (%)	10	25	40		10	25	40		10	25	40	
Hot starts - LDV (%)	0	25	20		0	25	20		0	25	20	
Stabilized - LDV (%)	90	50	40		90	50	40		90	50	40	
Daily VMT												
LDV	124,000	217,000	186,000	527,000	183,000	255,000	217,000	655,000	227,000	273,000	252,000	752,000
LDT_1	21,800	37,300	31,100	90,200	31,100	43,500	37,300	111,900	40,400	46,600	43,500	130,500
LDT_2	9,300	15,500	12,400	37,200	12,400	15,500	15,500	43,400	15,500	18,600	15,500	49,600
HDG	3,100	3,100	3,100	9,300	3,100	3,100	3,100	9,300	3,100	3,100	3,100	9,300
HDD	21,800	37,300	27,900	87,000	31,100	43,500	34,200	108,800	37,300	46,600	43,500	127,400
Total	180,000	310,200	260,500	750,700	260,700	360,600	307,100	928,400	323,300	387,900	357,600	1,068,800

Source: Kentuckiana Regional Planning and Development Agency, Louisville, Kentucky.

TABLE [illegible]6. DATA FOR MARION COUNTY

	1977 Daily VMT	1977 Average speed	2000 Daily VMT	2000 Average speed
Travel data				
Freeway/expressways	3,685,000	42	6,968,700	37
Arterials	5,981,000	17	7,366,200	20

	LDV	LDT1	LDT2	HDG	HDD	MC
VMT distribution						
All roads	0.823	0.078	0.016	0.046	0.032	0.004

Source: City of Indianapolis, Department of Metropolitan Development.

TABLE 117. DATA FOR ALLEN COUNTY

	Daily VMT			Average speed
	1975	1982	1987	
Travel data				
Ft. Wayne CBD				
Arterials	142,290	142,290	142,290	27
Collectors	11,250	11,250	11,250	27
Residential	13,010	13,010	13,010	8
CBD fringe				
Arterials	128,040	128,040	128,040	32
Collectors	11,460	11,460	11,460	32
Residential	12,070	12,070	12,070	10
Suburban (inside urbanized area)				
Freeway/expressway	183,800	221,480	248,565	43
Arterials	1,812,840	1,877,500	1,930,125	37
Collectors	196,735	205,550	209,130	37
Residential	229,145	237,040	243,510	15
Rural (outside urbanized area and inside study area)				
Freeway/expressway	204,930	258,910	298,175	47
Arterials	686,730	971,400	1,205,210	42
Collectors	124,000	175,400	217,620	42
Locals	92,550	130,915	162,425	15
Rural (outside urbanized area and outside study area)				
Freeway	51,000	63,850	73,050	47
Arterials	164,370	178,000	189,100	42
Collectors	254,020	275,000	292,200	42
Locals	25,410	27,500	29,200	15

	Age	LDV	LDT1, LDT2, HDG, HDD	MC
Vehicle age distribution (percent)				
For arterials, collectors, residential streets only	1	12.7	14.8	10.1
	2	9.4	10.2	12.3
	3	7.0	6.0	16.7
	4	9.5	10.0	12.5
	5	11.2	9.7	14.0
	6	9.4	7.8	12.1
	7	7.6	5.6	6.9
	8	7.2	5.3	3.8
	9	6.9	6.1	2.4
	10	5.4	3.7	4.3
	11	4.1	3.1	1.5
	12	2.8	2.1	0.9
	13	1.9	2.5	2.5
	14	1.5	2.4	
	15	0.9	2.2	
	16	0.6	2.0	
	17	0.5	1.9	
	18	0.5	1.7	
	19	0.5	1.5	
	20	0.4	1.4	
For freeways/expressways – Mobile 1 national averages are used.				

	LDV	LDT1	LDT2	HDG	HDD	MC
VMT distribution						
Freeway/expressways (national averages)	0.803	0.058	0.058	0.045	0.031	0.005
Arterials/collectors/residential	0.819	0.111	0.010	0.020	0.020	0.020

	Cold noncatalytic	Hot catalytic	Cold catalytic
Hot-cold starts (percent)			
Freeway/expressways	0	0	0
Arterials/collectors/residential (national averages)	20.0	27.3	20.6

Source: Pacific Environmental Services, Inc., Oak Brook, Illinois.

TABLE 118. DATA FOR LAKE AND PORTER COUNTIES

	Daily VMT			Average speed
	1975	1982	1987	
Travel data				
Arterials - urbanized area	3,500,613	3,704,564	3,873,276	15
Freeways - urbanized area	1,637,752	1,608,240	1,587,171	52
Arterials - nonurbanized area	678,181	826,883	949,440	34
Freeways - nonurbanized area	69,611	58,425	50,262	52

	LDV	LDT1	LDT2	HDG	HDD	MC
VMT distribution						
Arterials - urbanized area (Lake County)	0.507	0.230	0.033	0.110	0.110	0.010
Freeways - urbanized area	0.609	0.081	0.010	0.171	0.119	0.010
Arterials - nonurbanized area (Porter County)	0.539	0.071	0.009	0.218	0.152	0.010
Freeways - nonurbanized area	0.609	0.081	0.010	0.171	0.119	0.010

	Cold noncatalytic	Hot catalytic	Cold catalytic
Hot-cold starts (percent)			
Freeways	0	0	0
Arterials - urbanized area	18	22.5	38.5
Arterials - nonurbanized area	16	33	41

	Age	LDV	LDT1, LDT2, HDG, HDD	MC
Vehicle age distribution (percent)				
For arterials	1	12.5	14.2	8.8
	2	9.9	10.4	12.6
	3	8.2	7.8	18.7
	4	10.3	10.1	14.4
	5	12.0	10.0	14.3
	6	9.6	8.0	10.9
	7	7.4	5.5	6.4
	8	7.4	5.8	3.6
	9	6.7	6.1	1.9
	10	4.5	3.4	3.9
	11	3.4	2.8	1.4
	12	2.4	1.8	0.9
	13	1.6	2.3	2.0
	14	1.2	2.2	
	15	0.8	2.0	
	16	0.5	1.8	
	17	0.4	1.7	
	18	0.4	1.5	
	19	0.4	1.4	
	20	0.4	1.2	
For freeways - Mobile 1 national averages are used.				

Source: Pacific Environmental Services, Inc., Oak Brook, Illinois.

TABLE 119. DATA FOR ST. JOSEPH COUNTY

	Daily VMT			Average speed
	1975	1982	1987	
Travel data				
St. Joseph County - urbanized area				
Arterial/collector - central city	533,120	533,120	533,120	22
- remainder	2,222,292	2,272,230	2,308,780	32.5
Centroid/connector - central city	45,445	45,445	45,445	10
- remainder	250,576	255,905	259,825	10
Toll road	197,775	247,615	283,265	55
Expressways	344,332	431,090	493,170	55
St. Joseph County - rural area				
Arterial	253,000	257,600	260,100	45
Collector/minor arterial	387,670	395,000	400,000	45
Local	39,000	39,500	40,000	45

	LDV	LDT1	LDT2	HDG	HDD	MC
VMT distribution						
Expressway/toll road (national averages)	0.803	0.058	0.058	0.045	0.031	0.005
Arterials/collectors/centroids/local	0.799	0.124	0.014	0.020	0.020	0.023

	Cold noncatalytic	Hot catalytic	Cold catalytic
Hot-cold starts (percent)			
Expressway/toll road	0	0	0
Arterials/collectors/centroids/local	20.0	27.3	20.6

	Age	LDV	LDT1, LDT2, HDG, HDD	MC
Vehicle age distribution (percent)				
For arterials/collectors/centroids/ local	1	11.9	13.5	7.9
	2	9.9	10.2	10.7
	3	7.7	6.9	19.7
	4	9.3	9.7	21.1
	5	11.7	10.6	14.3
	6	10.4	8.8	14.5
	7	7.6	5.7	7.1
	8	7.3	5.3	4.0
	9	6.9	6.6	2.2
	10	4.9	3.4	3.5
	11	3.6	2.9	1.2
	12	2.5	1.9	0.8
	13	1.7	2.4	2.0
	14	1.3	2.2	
	15	0.8	2.0	
	16	0.6	1.9	
	17	0.5	1.7	
	18	0.5	1.6	
	19	0.5	1.4	
	20	0.4	1.3	
For expressways/toll roads - Mobile 1 national averages are used.				

Source: Pacific Environmental Services, Inc., Oak Brook, Illinois.

TABLE 120. STATEWIDE DATA

	1975 Annual VMT (million)
Interstate	
Rural	4,288
Urban	3,003
Primary	
Rural	6,861
Urban	2,741
Secondary	
Rural and urban (federal aid)	7,351
Rural and urban (state aid)	4,815
Rural and urban (other)	241
Local	
Rural	1,397
Urban	6,662
Total	37,362

Source: Indiana Highway Commission, Office of Highway Development, Traffic Statistics Section.

correction factors for temperature, speed, hot/cold/stabilized travel, air-conditioning, vehicle load, trailer towing, and humidity. Due to a lack of reliable data for Indiana, default values (FTP specific conditions) are used for air-conditioning, vehicle load, and trailer towing. Humidity affects oxides of nitrogen only and, thus, is irrelevant for this application. Temperature is taken at the statewide mean of 50°F. Even though Mobile I is designed to calculate emissions at the higher temperatures found on a midsummer day when ambient air quality is poor, the 50°F level was selected to make the inventories reported here compatible with those developed by PES under EPA sponsorship.

When local data are available for hot and cold starts, they are used in Mobile I (see Tables 114 through 119). If local figures are not available, the following national averages are used: for freeways and expressways, no hot and cold start mileage; and for all other roads, 20.0 percent cold non-catalytic, 27.3 percent hot catalytic, and 20.6 percent cold catalytic.

The most important correction factor is vehicle speed. Emissions are non-linear with respect to speed, so whenever possible, speed classes must be differentiated. Speed classes are created by dividing travel between road types (e.g., freeways, arterials, and locals).*

Once the emission factors (grams of HC or CO per mile traveled) have been adjusted for the above conditions, a countywide factor is derived by aggregating across the number of miles driven by vehicles of various ages and on the various types of roads. Travel by vehicles of various ages is weighted in relation to travel proportions (see the last column of Table 121). Except for Allen, Lake, Porter, and St. Joseph Counties, the data used in calculating travel proportion, the distribution of vehicles by age and the annual travel by vehicles of a specific age, are national averages contained in Mobile I (Table 121). In Allen, Lake, Porter and St. Joseph Counties, the age distributions provided by PES were used so as to maintain data comparability.†

Once the factors have been weighted by vehicle age, daily inventories for each vehicle type (e.g., LDV) are calculated by multiplying the emission factors by the appropriate daily VMT figures and then aggregating across highway types.

For example, the LDV emission factor for freeways is multiplied by the daily VMT by LDV's on freeways. This is added to the product of the LDV emission factor for arterials and VMT by LDV's on arterials. This process continues until all highway classes within an area are covered. The resulting

---

*In Lake and Porter Counties, PES divided speed classes into 5 mph increments over relatively small travel zones. Such refinement is unnecessarily detailed for this report and, thus, the methods used in the remaining areas of Indiana are also used in Lake and Porter Counties.

†PES used 1975 county vehicle registrations for the vehicle age distributions of VMT (vehicle miles traveled). This method has a major drawback; the low vehicle sales during the 1973 to 1974 recession and gas shortage are projected into the future. To overcome this problem, 4- or 5-year moving averages should be used with local data.

TABLE 121. TRAVEL WEIGHTING FACTOR CALCULATION

Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a)*(b)	((a)*(b)/sum) Travel fraction
1	0.075	15,900	1,192.5	0.106
2	0.107	15,000	1,605.0	0.142
3	0.107	14,000	1,498.0	0.133
4	0.106	13,100	1,388.6	0.123
5	0.100	12,200	1,220.0	0.108
6	0.092	11,300	1,039.6	0.092
7	0.085	10,300	875.5	0.077
8	0.077	9,400	723.8	0.064
9	0.066	8,500	561.0	0.050
10	0.052	7,600	395.2	0.035
11	0.039	6,700	261.3	0.023
12	0.027	6,600	178.2	0.016
13	0.018	6,200	111.6	0.010
14	0.014	5,900	82.6	0.007
15	0.009	5,500	49.5	0.004
16	0.006	5,100	30.6	0.003
17	0.005	5,000	25.0	0.002
18	0.005	4,700	23.5	0.002
19	0.005	4,400	22.0	0.002
20	0.004	4,400	17.6	0.002
		Sum:	11,301.0	

Source: Mobile I

figure will be daily emissions by a particular class of vehicles, in this example, LDV's.

Implicit in the above calculations is the ability to divide VMT between LDV, LDT_1, LDT_2, HDG, HDD and MC. Local figures were used as supplied in Tables 114 through 120. In the case of Allen, Lake, Porter and St. Joseph Counties, the data supplied by PES was again reluctantly used.*

Adding the daily emissions for the various vehicle types yields total daily emissions for a specific area. For Allen, Clark, Floyd, Lake, Porter, and St. Joseph Counties, all the data used in calculating 1975, 1982 and 1987 inventories are included in Tables 114 through 120. For Marion County, data was provided for 1977 and 2000. This data is changed to 1975, 1982 and 1987 by linear interpolation (Table 122). Statewide data is provided for 1975 only. To obtain 1982 and 1987 figures, VMT are assumed to increase at the same rate as the vehicle population.

$$\text{Annual VMT increase} = (\text{annual population growth})(\text{annual increase in vehicles per capita})$$

$$= (1.0085794)(1.02391)$$

$$= (1.00326945)$$

thus $1982\ \text{VMT} = (1.00326945)^7\ (1975\ \text{VMT}) = (1.25257)(1975\ \text{VMT})$

and $1987\ \text{VMT} = (1.00326945)^{12}(1975\ \text{VMT}) = (1.47117)(1975\ \text{VMT})$

(see Table A-10).

To calculate the effect of an I/M program on emissions, EPA-derived Appendix N^2 credits (percent reductions) are applied to the basic emission factors prior to any aggregation. I/M credits are given for each of the following: carbon monoxide and hydrocarbons; various technologies of vehicles (technology 1 vehicles built prior to 1975, technology 2 vehicles built from 1975 to 1979, technology 3 vehicles built in 1980, and technology 4 vehicles built after 1980); with and without mechanic's training; with stringency levels of 10, 20, 30, 40 and 50 percent; and for the number of years an I/M program has been in effect. In this study, I/M includes mechanic's training, a stringency level of 30 percent, and an assumption that the program will be in effect for 5 years (from 1982 to 1987). These I/M credits are also specific to vehicle type. Tables 124 and 125 contain the credits for light-duty vehicles (LDV)

---

*VMT by vehicle type was distributed in accordance with 1975 vehicle registrations. Again, problems appear. First, vehicles of all types are assumed to travel the same distance daily (e.g., an auto travels the same distance as a diesel truck). Second, all vehicles registered in a county are assumed to travel exclusively in that county. This problem is most acute in Lake and Porter Counties where a large number of trucks are registered in the area, yet travel extensively outside the area. Since I/M does not apply to heavy trucks, this overestimate of truck VMT in Lake and Porter Counties will underestimate the impact of I/M on mobile emissions in these areas.

TABLE 122. ADJUSTED DATA FOR MARION COUNTY*

	1975		1982		1987	
	VMT	Average speed	VMT	Average speed	VMT	Average speed
Freeway/expressways	3,399,500	42	4,399,000	41	5,113,000	40
Arterials	3,861,000	17	6,282,000	18	6,583,000	18
Local†	1,852,100	15	2,136,200	15	2,339,200	15

*Data is by linear interpolation of Table A-3.

†Local VMT is 20 percent of all other VMT.

TABLE 123. ADJUSTED STATEWIDE DATA*

	1975 VMT (000)	1982 VMT (000)	1987 VMT (000)	Average speed
Interstate				
Rural	13,300	16,700	19,600	50
Urban	9,300	11,700	13,700	45
Primary				
Rural	21,300	26,700	31,300	45
Urban	8,500	10,700	12,500	40
Secondary				
Rural and urban (federal aid)	22,800	28,600	33,600	40
Rural and urban (state aid)	15,000	18,700	22,000	40
Rural and urban (other)	700	900	1,100	40
Local				
Rural	4,300	5,400	6,400	30
Urban	21,700	25,900	30,400	20
Total	116,000	145,300	170,700	

---

*Annual vehicle growth rates are applied to data in Table A-7.

TABLE 124. HYDROCARBON I/M CREDITS FOR LDV, LDT 1 AND 2

Technology	Stringency	Years of I/M 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Without Mechanic's Training		
I	0.10	3, 6,11,15,19,24,27,31,35,39,41,42,44,46,47,48,49,51,
	0.20	4, 8,13,18,22,24,34,36,40,42,45,46,49,50,51,52,54,56,57,
	0.30	7,14,20,28,34,39,43,46,49,52,54,55,57,58,59,60,61,62,63,
	0.40	8,15,22,30,36,41,46,49,52,54,56,58,59,61,62,63,64,65,65,
	0.50	8,16,23,31,37,42,46,50,53,55,57,59,60,61,62,63,64,65,66,
II	0.10	4, 6, 9,11,16,19,20,23,25,28,29,30,32,33,35,36,36,37,38,
	0.20	6,11,16,20,23,27,31,33,36,38,40,41,43,44,45,46,47,48,49,
	0.30	10,18,24,28,33,36,40,42,45,47,48,50,51,53,55,55,55,57,58,
	0.40	12,20,26,32,37,40,43,46,49,51,52,54,55,56,57,59,59,60,61,
	0.50	13,22,28,34,39,43,46,49,51,54,55,57,58,59,61,61,62,63,64,
III	0.10	4,11,22,32,42,49,54,58,62,64,66,68,69,71,72,73,74,74,75,
	0.20	4,13,25,37,46,53,58,62,65,67,69,71,72,73,74,75,76,77,77,
	0.30	4,15,28,40,49,55,60,64,67,69,71,72,74,75,76,77,77,78,79,
	0.40	5,17,31,43,51,58,63,66,69,71,73,74,75,76,77,78,79,79,80,
	0.50	5,18,32,44,53,59,63,67,70,72,73,75,76,77,78,79,79,80,81,
IV	0.10	3, 7,14,23,31,38,44,49,53,56,58,60,62,63,65,66,67,68,69,
	0.20	3, 7,15,24,33,40,46,51,54,57,60,62,63,65,66,67,68,69,70,
	0.30	3, 7,16,25,34,41,47,51,55,58,60,62,64,65,67,68,69,70,71,
	0.40	3, 8,17,26,35,42,48,52,56,59,61,63,65,66,68,69,70,71,71,
	0.50	3, 8,17,27,36,43,49,54,57,60,62,64,66,67,68,69,70,71,72,
With Mechanic's Training		
I	0.10	6,13,17,20,25,32,35,40,45,47,49,50,53,53,54,56,57,57,
	0.20	9,14,19,25,31,36,43,45,50,51,53,54,55,56,58,58,61,63,63,
	0.30	12,19,27,35,41,44,51,53,55,57,59,61,61,63,65,65,66,66,67,
	0.40	13,24,33,40,46,50,54,57,59,61,63,65,65,66,68,68,69,70,71,
	0.50	14,25,35,42,48,53,56,59,62,64,65,66,68,69,70,70,71,72,72,
II	0.10	9,13,15,18,22,26,28,31,33,35,37,39,40,42,44,44,44,46,48,
	0.20	13,16,20,26,31,34,38,41,43,44,45,47,48,50,52,52,53,54,55,
	0.30	14,21,28,33,38,41,45,47,50,52,53,54,56,57,59,60,61,61,62,
	0.40	15,24,31,36,41,44,48,50,52,54,56,58,58,60,61,62,63,63,65,
	0.50	16,26,33,39,43,47,50,53,55,57,59,60,61,63,64,65,65,66,67,
III	0.10	10,33,51,59,67,70,74,76,78,80,80,81,82,83,84,84,85,85,86,
	0.20	13,36,53,62,69,73,76,78,80,81,82,83,83,84,85,85,86,86,87,
	0.30	15,38,54,64,70,74,77,79,81,82,83,84,85,85,86,86,87,87,87,
	0.40	16,39,54,64,70,74,77,80,81,83,84,85,85,86,87,87,87,88,88,
	0.50	16,39,54,64,70,74,77,80,81,83,84,85,86,86,87,87,88,88,88,
IV	0.10	7,24,36,52,54,65,66,69,72,75,75,75,77,79,79,80,80,81,81,
	0.20	11,29,45,56,63,68,70,74,76,76,78,80,80,81,82,82,83,84,84,
	0.30	12,32,46,58,65,69,72,75,76,77,80,81,81,82,83,83,84,85,85,
	0.40	14,36,52,62,69,73,76,78,80,81,82,83,84,85,85,86,86,87,87,
	0.50	15,38,54,64,70,74,77,79,81,83,84,85,85,86,87,87,88,88,88,

Source: Mobile I.

Reproduced from best available copy.

TABLE 125. CARBON MONOXIDE I/M CREDITS FOR LDV, LDT 1 AND 2

Technology	Stringency	Years of I/M 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Without Mechanic's Training		
I	0.10	7,13,17,22,26,30,32,35,37,40,41,42,44,45,46,47,48,50,
	0.20	9,17,22,27,31,35,37,40,42,44,46,48,49,51,52,53,54,55,56,
	0.30	12,21,27,32,36,40,44,47,49,52,53,55,56,58,59,60,61,62,62,
	0.40	14,23,29,35,39,43,47,50,52,55,56,58,59,60,61,62,63,64,65,
	0.50	15,25,31,36,41,45,49,52,54,56,58,59,61,62,63,64,65,65,66,
II	0.10	10,15,20,23,26,28,31,32,34,35,37,37,38,40,41,41,42,43,44,
	0.20	17,25,29,32,36,38,41,42,44,46,47,48,49,50,51,52,52,53,54,
	0.30	21,31,36,40,44,47,49,51,53,55,56,57,58,59,60,61,62,62,63,
	0.40	23,34,39,43,46,49,52,54,56,57,59,60,61,62,63,63,64,65,65,
	0.50	25,36,41,45,49,52,54,56,58,60,61,62,63,64,65,66,67,67,68,
III	0.10	0, 4, 8,14,20,26,30,33,35,39,42,44,45,48,49,50,50,53,55,
	0.20	0, 5,10,18,23,28,32,37,40,43,45,47,49,51,52,53,54,56,57,
	0.30	1, 6,13,21,27,33,38,42,45,48,50,52,54,56,57,59,60,61,62,
	0.40	1, 6,14,22,28,34,39,43,47,49,52,54,55,57,58,60,61,62,63,
	0.50	2, 7,14,22,29,35,40,44,47,50,52,54,56,58,59,60,61,62,63,
IV	0.10	0, 2, 7,13,19,24,29,33,37,40,43,45,47,49,50,52,53,54,55,
	0.20	0, 4,11,19,26,32,37,42,45,48,51,53,55,56,58,59,60,62,62,
	0.30	1, 5,13,21,28,34,40,44,48,51,53,55,57,58,60,61,62,63,64,
	0.40	2, 8,18,28,36,42,47,52,55,58,60,62,63,65,66,67,68,69,70,
	0.50	3,12,23,33,42,48,53,57,60,63,65,66,68,69,70,71,72,73,74/
With Mechanic's Training		
I	0.10	11,20,26,30,34,40,43,47,50,52,53,55,58,57,58,59,61,60,
	0.20	16,23,29,35,40,43,49,51,54,55,57,58,59,60,62,62,64,66,66,
	0.30	20,29,37,42,47,49,55,57,59,61,62,64,64,66,67,68,68,68,70,
	0.40	22,34,41,46,51,55,58,61,63,64,65,67,68,69,70,70,71,72,73,
	0.50	23,35,42,48,53,57,60,62,65,66,68,69,70,71,72,72,73,74,74,
II	0.10	17,25,27,31,35,38,40,43,44,45,49,50,50,53,54,54,55,56,58,
	0.20	26,33,36,41,46,48,51,54,56,57,58,59,60,61,63,63,64,65,66,
	0.30	30,41,47,50,54,57,59,61,63,65,65,66,67,68,69,70,71,71,71,
	0.40	32,45,50,54,57,60,63,64,65,67,68,69,70,71,72,72,73,73,74,
	0.50	33,47,52,56,60,62,65,67,68,69,70,71,72,73,74,74,75,75,76,
III	0.10	5,24,40,48,56,60,65,67,69,72,72,74,75,76,77,78,78,79,79,
	0.20	8,27,42,51,58,63,66,69,71,73,74,76,76,77,78,79,79,80,80,
	0.30	11,29,43,52,59,64,67,70,72,74,75,76,77,78,79,80,80,81,81,
	0.40	13,30,43,52,59,64,68,71,73,75,76,77,78,79,80,80,81,82,82,
	0.50	14,30,43,52,59,64,68,71,73,75,76,77,78,79,80,81,81,82,82,
IV	0.10	9,30,41,56,58,68,68,71,74,77,77,78,79,81,81,81,81,82,83,
	0.20	15,37,51,60,66,70,72,76,77,78,80,82,82,82,83,84,84,85,85,
	0.30	18,39,52,62,68,71,74,77,78,79,82,82,82,84,84,84,85,86,86,
	0.40	21,43,57,66,71,75,78,80,81,83,84,85,85,86,86,87,87,88,88,
	0.50	23,44,58,66,72,76,79,81,83,84,85,86,86,87,88,88,88,89,89/

Source: Mobile I.

Reproduced from
best available copy.

found in the current version of Mobile I and are those anticipated for the final rulemaking of Appendix N. These credits differ substantially from those found in the May 1977 version of Appendix N.

In this report, six I/M alternatives are analyzed. These alternatives differ in their geographic coverage (i.e., areas where registered vehicles are subject to mandatory inspection and maintenance). In alternatives 2, 3, and 4, only vehicles registered in the seven nonattainment counties over 200,000 population are subject to mandatory I/M. Thus, the I/M credits must be applied only to the VMT driven by inspected vehicles in this area. In the seven nonattainment counties, journey to work data is used to calculate the VMT generated by uninspected vehicles from surrounding areas. The following assumptions are made in calculating these proportions: work trips constitute all VMT; each work trip is the same length; and when the work trip is between counties, trip length is divided equally between the counties. The proportion of VMT by inspected vehicles in a county with I/M is thus:

$$1 - \frac{\text{(workers in county and living in areas without I/M)}}{2\,\text{(workers in county)}} \qquad (1)$$

These figures are reported in Table 126 and Table 127. The 85 counties without I/M also receive some benefits because some inspected vehicles travel in this 85-county region. Here, travel between inspected and uninspected areas is assumed to be equivalent in both directions. Thus, 2.4 percent of the VMT in the 85 non-I/M counties is by vehicles subect to I/M.

In alternative 5, vehicles registered in parts of Elkhart, Hamilton, and Johnson Counties are inspected, as well as all the vehicles in the seven nonattainment counties covered in alternatives 2, 3, and 4. This expanded coverage increases the proportion of VMT traveled by inspected vehicles in Marion and St. Joseph Counties (the formula and assumptions used in alternatives 2, 3, and 4 are also used in alternative 5). In addition to benefits in the seven nonattainment counties, alternative 5 also yields benefits in the remainder of the state. Here the proportion of inspected VMT includes 2.4 percent for travel by vehicles registered in the seven nonattainment counties (same as above for alternatives 2, 3, and 4) plus 2.2 percent for travel in the inspected parts of Elkhart, Hamilton and Johnson Counties. The latter figure is the proportion of vehicles in the 85-county area that are registered in the inspected parts of Elkhart, Hamilton and Johnson Counties (15,000/2,500,000).

With alternatives 1 and 6, all vehicles registered in the state are subject to emissions inspection. Again formula (1) above is used to calculate the proportion of VMT subject to I/M credits. These proportions are reported in Tables 126 and 127.

TABLE 126. JOURNEY TO WORK BY AUTO

County	Working in county	Working in county and living in seven-county area	Working in county and living in remainder of state	Working in county and living out of state	Working in county and living in urban area not in seven-county area
Clark	28,002	17,361	3,418	7,223 (KY)	0
Floyd	11,663	8,639	1,051	1,973 (KY)	0
Allen	110,011	91,011	15,851	3,149 (OH)	0
Marion	304,709	240,771	63,938	0	13,407
St. Joseph	74,955	66,167	5,542	3,246 (MI)	986
Lake	151,868	132,846	3,931	15,091 (IL)	0
Porter	21,916	18,450	3,083	383 (IL, MI)	0

Source:[3] U.S. Census of Population, Subject Report, Journey to Work PC(2)-6D, Department of Commerce, 1970.

TABLE 127. PROPORTION OF VMT SUBJECT TO I/M CREDITS

County	Alternative 2, 3, 4	Alternative 5	Alternative 1, 6
Clark	0.810	0.810	0.871
Floyd	0.870	0.870	0.915
Allen	0.913	0.913	0.985
Marion	0.895	0.917	1.000
St. Joseph	0.941	0.948	0.978
Lake	0.937	0.937	0.950
Porter	0.921	0.921	0.991
Lake and Porter (combined)	0.935	0.935	0.955
Rest of state	0.024	0.046	0.978

Source: Based on data in Table 126. See text for assumptions and formulae.

REFERENCES

1. U.S. Environmental Protection Agency. Mobile Source Emission Factors For Low-altitude Areas. Final Document. EPA-400/9-78-006. March 1978.

2. U.S. Environmental Protection Agency. Appendix N - Emission Reduction Achievable Through Inspection and Maintenance of Light-Duty Vehicles, Motorcycles and Light- and Heavy-duty trucks. Proposed Rule. Federal Register 24(84):22177-22183. May 2, 1977.

3. U.S. Census of Population, Subject Report. Journey to Work PC(2)-6D. Department of Commerce, 1970.

APPENDIX B

ESTIMATED FUEL SAVINGS RESULTING FROM I/M FOR 1987

INTRODUCTION

There are no firm figures to date regarding the effect of an I/M program on fuel economy. It is generally accepted that the inspection sequence has a favorable influence on fuel economy by forcing vehicle owners to maintain their vehicles at higher standards than they would in the absence of I/M.

Estimates of fuel savings vary from a 4 percent improvement noted in California's Riverside Trial Program (idle mode)[1] to a 10 percent savings for the first 6 months that Hamilton Test Systems operated a program for Arizona.[2] These figures are for light-duty vehicles that failed the emissions test and have thus been forced to be repaired for compliance. Noting such studies as these, EPA has suggested a range of 5 to 10 percent[3] for expected fuel savings on repaired vehicles. A 7 percent figure is used here as an average for calculations. This figure may be revised if the results from an ongoing study in Oregon prove more conclusive.

It should be noted that these fuel economy figures may be misleading. If the 4 percent improvement figure noted in California is "deteriorated" over 1 year and distributed equally over the total vehicle population tested, fuel economy improvement is only 0.6 percent. Over time, the fuel economy realized by I/M will decline. This is particularly true for that segment of the vehicle population that upgraded maintenance levels to meet I/M standards.

There are also other important variables to be considered that influence fuel economy figures, and perhaps can be pointed to as the reasons for so many different study results thus far. These include test mode, characteristics of the pertinent vehicle population, geographic coverage of the program and stringency rate used as well as the amount of time the program has been in effect.

Keeping these in mind, some interesting facts and figures on I/M fuel savings may then be quoted. The U.S. Department of Transportation in the "Department of Motor Vehicle Diagnostic Inspection Program (DMVDIP)" projected nationwide impacts of I/M related fuel savings. These show a resulting conservation of 1.8 billion gallons of gasoline/year or $1.1 billion saved by consumers.[4] While the accuracy of this estimate is open to speculation, its magnitude is impressive. Hamilton Test Systems has noted a decrease in vehicle failure in the field, thus saving vehicle owners towing charges as well as other related expenses. The EPA has noted that improvement in fuel economy is greatest when the failure rate is minimized. This occurs because lowering the stringency rate isolates those vehicles farthest out of compliance. This segment of the population has the greatest potential for improvement since it is the least adequately maintained vehicle group.

A rough estimate of fuel savings for failed vehicles resulting from I/M implementation in the seven nonattainment counties in Indiana can be calculated for 1987. Assumptions include using a 30 percent stringency rate, an average improvement in fuel economy for failed vehicles of 7 percent, a predicted 1987 vehicle population of 4,681,920 and VMT of 31,286,284, an average fleet mileage figure of 24.817 miles per gallon and a cost of $0.60* per gallon for gasoline. The fuel savings in gallons would be 23,128 per day, or $13,875 per day. The total savings for 1987, using these assumptions is 8,441,720 gallons or $5,065,032. Table 128 shows how this result would vary with different program area coverage, as well as different average improvements in fuel economy.

For alternatives having statewide coverage, larger fuel savings would result. In 1987, 126,176 gallons per day could be saved, or $75,700 per day. This would result in 46,054,240 gallons of fuel saved in this year, or a dollar amount of $27,632,544. These savings would accrue to all vehicle owners participating in the I/M program, providing they maintain their vehicles before (or after) inspection.

DETAILED CALCULATIONS

The number of gallons of fuel saved by improving vehicle fuel economy through I/M implementation can be estimated for 1987. Four factors are critical in deriving this figure. They are: (1) the stringency rate set for the inspection procedure, (2) average fleet fuel consumption rate (miles per gallon), (3) total vehicle miles traveled (VMT), and (4) actual fuel economy improvement resulting from I/M.

Since a 30 percent stringency rate has been chosen, it can be assumed that it will not vary. The average mileage rate for the 1987 vehicle population will also remain constant. Thus, the two main determinants of the level of fuel savings likely to result will be the different VMT figures for the different geographic coverages and the level of improvement in fuel economy experienced. After a fleet mileage figure and the total VMT for 1987 have been calculated, the relationship between fuel economy improvement and total fuel savings can be observed.

Average fleet-mileage in 1987 is based on a VMT figure for the light duty vehicles (LDV's) in the affected area (either the seven county area or the entire state). Table 129 contains a breakdown of the 1987 fleet by model year based on the EPA Mobile I computer program. Since I/M compliance is not required for vehicles over 13 years old or those under 1 year old, the relevant

---

*This $0.60 per gallon figure is representative of present fuel prices. It should be noted that if this figure increases by 1987, a greater dollar savings will be realized with an I/M program.

TABLE 128. POTENTIAL DAILY FUEL SAVINGS FROM I/M FOR SELECTED COUNTIES IN 1987 (GALLONS)*

Increase in fuel economy for failed vehicles (%)	Gallons saved when geographic coverage of program is:		Fuel savings as a percentage of fuel consumed by the total vehicle population covered by I/M§
	Seven counties†	Statewide‡	
2	6,608	36,050	0.6%
3	9,912	54,075	0.9
4	13,216	72,100	1.2
5	16,520	90,126	1.5
6	19,824	108,151	1.8
7	23,128	126,176	2.1
8	26,431	144,201	2.4
9	29,735	162,226	2.7
10	33,039	180,251	3.0

---

[*] This table assumes a 30 percent stringency level for all different levels of geographic coverage.

[†] Pertains to Alternatives 2,3,4, and 5.

[‡] Pertains to Alternatives 1 and 6.

[§] Fuel savings as a proportion of total fuel consumption is the same for different levels of geographic coverage for a specific increase in fuel economy.

TABLE 129. TRAVEL WEIGHTING FACTOR CALCULATION FOR LIGHT-DUTY VEHICLES

Year	Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a) * (b)	[(a) * (b)/sum] travel fraction
1987	1	0.075	15900	1192.5	0.106
1986	2	0.107	15000	1605.0	0.142
1985	3	0.107	14000	1498.0	0.133
1984	4	0.106	13100	1388.6	0.123
1983	5	0.100	12200	1220.0	0.108
1982	6	0.092	11300	1039.6	0.092
1981	7	0.085	10300	875.5	0.077
1980	8	0.077	9400	723.8	0.064
1979	9	0.066	8500	561.0	0.050
1978	10	0.052	7600	395.2	0.035
1977	11	0.039	6700	261.3	0.023
1976	12	0.027	6600	178.2	0.015
Pre-1976	13+	0.066	5491	362.4	0.032

Sum: 11301.0

FROM: Mobile I, EPA; January 1978.

vehicle population consists of model year 1976 and newer vehicles, excluding 1987 model year LDVs. Combining these figures with anticipated annual mileage accumulation rates that are model year specific yields a series of travel fractions.

Totalling the travel fractions for the LDV population that will be affected by I/M results in a figure of 0.862. Consequently, total LDV VMT figures should be reduced by 13.8 percent to exclude noninspected vehicles from fuel savings calculations.

By assuming that vehicles meet the average mile per gallon figures set by the EPA, an average fuel consumption rate for all vehicles less than 13 years old can be calculated (Table 130). The average fleet mileage arrived at by this method is 24.817 miles per gallon.

VMT figures (corrected to account for the portion of LDV travel that will be affected by I/M) for the alternative geographic program coverage areas are presented in Table 131. Occurring in the seven county area were 31,286,284 VMT and 170,688,000 VMT occur statewide. The assumption is made that traffic traveling out of the relevant area and traffic entering it cancel each other out. These figures are based on various data sources that provided 1975 and 1977 VMT figures. The assumption is made that vehicles in 1987 travel the same number of VMT as they do now. Thus VMT have been projected forward in the same manner as the relevant vehicle population (see Section 3).

As previously mentioned, Table 128 reports fuel savings for various options and various potential rates of fuel economy. Relevant LDV VMT were divided by the average fleet mileage figure and multiplied by the stringency rate assumed (30 percent) because fuel savings will occur only for those vehicles that are forced to perform maintenance as a result of I/M. This number is derived for each of the different program area coverage possibilities. Multiplying it by the various fuel savings levels results in a gallons per day figure.

This method will underestimate fuel savings figures for two reasons. First. it does not take into account any fuel savings that passed vehicles may realize because of the preventive maintenance performed prior to going through the inspection sequence. No figures that can be used to calculate this effect have been collected to date.

This method also ignores fuel savings benefits expected for light duty trucks type 1 and 2 (LDT 1, LDT 2). These vehicle classes are covered by I/M so they will realize a fuel savings. There are no EPA fuel economy standards on which to base an estimated 1987 fleet mileage figure for both types of light duty trucks (LDT's).

TABLE 130. EPA MPG SPECIFICATIONS AND AVERAGE FLEET MILEAGE FOR LDVs COVERED BY I/M IN 1987

Year	EPA mileage standard	Travel fraction[*]	$\frac{\text{Column (1) x column (3)}}{0.968}$
1986	27.5	0.142	4.530
1985	27.5	0.133	4.243
1984	27	0.123	3.853
1983	26	0.108	3.258
1982	24	0.092	2.562
1981	22	0.077	1.965
1980	20	0.064	1.485
1979	19	0.050	1.102
1978	18	0.035	0.731
1977	17.5	0.023	0.467
1976	16.8	0.015	0.292
	Total	0.862[†]	24.488

[*] From Table 128.

[†] Note: This column totals less than 1 indicating that part of the vehicle population is 12 or more years old.

SOURCE: Federal Register, Book 1, Vol. 42, No. 126, p. 33534, Thursday, June 30, 1977 and Table B-1.

TABLE 131. ESTIMATED DAILY LIGHT DUTY VEHICLE VMT FIGURES FOR SELECTED COUNTIES AND AREAS FOR 1987.

County	Daily vehicle miles traveled (thousands)	Total
Allen	5,416,430	
Clark	2,157,900	
Floyd	932,100	
Lake & Porter	6,460,149	
Marion	11,696,000	
St. Joseph	4,623,705	
		31,286,284
Statewide	170,688,000	170,688,000

REFERENCES

1. Rubestein, G., R. Ingels, R. Weis, and A. Wong. Vehicle Inspection and Maintenance. California Program. California Air Resources Board. SAE Paper No. 760557.

2. Automotive Fleet. Benefits of a Vehicle Inspection Program. Reprinted for Hamilton Test Systems, Inc. July 1975.

3. Telephone Conversation(s) - Bruce Everlane, U.S. Environmental Protection Agency, Washington, D.C. May 17, 1978.

4. U.S. Department of Transportation. Motor Vehicle Diagnostic Inspection Demonstration Program. October 1977.

APPENDIX C

PUBLIC INFORMATION PROGRAMS

INTRODUCTION

Experiences in several states that have recently established inspection/maintenance (I/M) programs emphasize the importance of providing information about the goals of emissions testing to the public. It is crucial that the public be introduced to the basic need for and benefits of I/M during the early stages of implementation. A well thought out public education effort can help eliminate potentially difficult implementation problems. How and why I/M came into being, the requirements it places on the public, consumer protection guarantees, secondary benefits such as fuel savings, and a basic understanding of the health and pollution consequences of the program should all be included in the information that is made public.

METHODOLOGY

To estimate the costs of public information programs all states with experience in I/M public information programs were contacted. This includes states with currently operational programs and those just beginning the early planning stages. The U.S. Environmental Protection Agency (EPA) was consulted to determine basic program elements and a literature search was conducted. From contacts and research, a full range of possible activities was established and basic cost figures derived. It is important to note that the range of possible activities and comprehensiveness of public information programs varies considerably. Therefore, broad assumptions concerning the range of public information activities which Indiana will conduct must be made in order to present potential cost figures. These assumptions will be made clear in the following sections.

INITIAL PUBLIC RELATIONS PROGRAMS

Initial public information efforts should begin several months to a year before an I/M sequence is implemented. It may also be beneficial to implement the program in phases. During the early stages of implementation a voluntary inspection and counseling approach without fines or requirements can ease the transition to I/M by lessening consumer distaste for inspection procedures. After implementing an I/M program in Cincinnati almost everyone connected with it agreed that a phasing-in process would have eliminated many of the problems that came up.

Program Funding

The first step in setting up a public education program is to secure funding. The EPA has provided grant money in the past to several states for this purpose. The size of these grants is usually $15,000. However, US EPA has not comitted itself to providing this level of funding. These grants are subject to the level of funding approved by Congress. EPA funds are made available through their regional offices. Both Rhode Island and Massachusetts are establishing public information programs with EPA grant funds. Rhode Island is in the first year of a mandatory inspection and voluntary maintenance program. It is the first state to implement a system of certified inspection stations based in private garages.

Potentially Useful Interest Groups

There are many private and public organizations that may be helpful in spreading around program information. In Rhode Island and Massachusetts the local lung associations have been given the job of organizing the public information effort for I/M. Environmental and clean air groups, the League of Women voters and the American Automobile Association may all prove helpful. Among other organizations, the Tri-state Air Committee, Inc. and the Izaak Walton League of America have already shown interest in the Indiana I/M effort.

In addition to these groups, automobile interests may be tapped. New car dealers and private businesses that have been licensed as certified state inspection stations are likely areas in which to focus information efforts. Manufacturers of emission analyzers and the automobile repair parts industry both have an interest in successful program implementation.

Mass Media

Some of the most effective forums for presenting information to the public are radio, television and newspaper spots. EPA recommends extensive use of television and radio prime time spot announcements. Depicting an important public official, such as the governor, having his car inspected on television has proved to be a very successful tactic. Careful use of these tools will result in maximum exposure to I/M for a given dollar expense.

Other Publicity Measures

As powerful as mass media are in spreading information, other methods should be used in conjunction with them. Oregon found that bumper stickers (at $0.10 to 0.15 each) were effective. In New Jersey new car dealers and private service stations that purchased emission analyzers were asked by the state to answer questionnaires about the analyzer purchased and about the station itself. Upon receipt of the completed survey forms, the state sent each respondent a poster to display and placed those stations on a list of approved certified inspection stations. This list was distributed to owners of vehicles that failed inspection, to encourage them to patronize those particular stations.

Also, it is possible to purchase and use vans to help the public gain exposure to I/M. Equipping these vehicles with HC/CO analyzers and staffing them with knowledgeable personnel provide a good forum to answer commonly asked questions. Vans can travel to shopping centers and schools and perform free emissions tests as well as distribute informational pamphlets.

Informational pamphlets have usually been designed for and included in registration mailings to minimize added postage costs. When creating such a pamphlet, the State of Indiana should keep sight of several things. It should not be overly detailed or excessively technical. The average person should be comfortable with the level of information it presents. It should emphasize the program's advantages such as cleaner air, health benefits, and fuel conservation, but should not promise specifics. A short, catchy brochure will be most effective. Including listings of testing facilities, their location, and their hours of operation may be desirable.

Finally, a more complete technical handbook may be designed or purchased and made available in schools and libraries. Some auto manufacturers may provide their own handbooks free of charge for this purpose.

ONGOING PUBLIC RELATIONS

After initial public exposure to I/M is accomplished, a less intense ongoing informational effort will be sufficient.

The ongoing public information program costs and elements are not as variable as the initial program elements. The major elements found in other state's programs are the same elements described above for the basic initial costs; a pamphlet mailed to each motorist and periodic mass media coverage, usually spot announcements and newspaper advertisements.

PUBLIC INFORMATION PROGRAM COSTS

Costs for I/M public relations can vary considerably depending upon the local situation. The extent of emissions testing is one determinant. Media coverage may be obtained free of charge since much of this information falls into the category of public service announcements. Printed posters and mailings can be quite expensive, running as high as $1.00 per vehicle. Van costs may vary greatly. If used vehicles can be purchased, costs will be much lower than if new vans are obtained. Oregon has successfully utilized old post office vehicles for this need.

A survey of public relation program costs in other states was conducted to provide an idea of what the average cost of this type of effort has been in the past. The usual manner in which these figures are reported is in an annual cost per vehicle covered by the program. A St. Louis study reported public relations costs of $0.06 per vehicle.* In "Evaluation of Mandatory Vehicle Inspection and Maintenance Programs," the California Air Resources Board settled on a $0.10 per vehicle figure. This estimate covers press releases, public service announcements (production) for radio and television, and audiovisual presentations.

Under contract to the state of Arizona to conduct emissions tests, Hamilton Test Systems, Inc. has found that their public relations efforts run between $0.10 and $0.12 per vehicle. This estimate covers both initial and ongoing costs. Their campaign consists of the distribution of a color pamphlet, radio spot announcements, and news coverage.

At this early stage an exact cost figure can not be determined for Indiana's public information program. A fairly good estimate may be made, however. Once the exact make-up of the public relations package is known this estimate can be revised. The $0.12 per vehicle figure will be used here. It is assumed that I/M will begin in 1982. The $0.12 figure should be multiplied by the relevant vehicle population, projected to 1982. Table 132 lists projected 1982 statewide vehicle registrations and figures for the seven urban counties. These figures represent light duty vehicles, light duty trucks (class 1 and 2) and motorcycles. This is the entire portion of the vehicle population that I/M will cover.

A statewide I/M program would cover 3,794,847 vehicles. Public relations costs to cover this population will run around $455,400. Statewide coverage relates to alternatives 1 and 6.

Certain adjustments will have to be made to this figure to account for the special nature of some of the alternatives evaluated in this report. For example, alternative 6 designates urban portions of the seven county area as being covered by contractor-run emissions inspection facilities while some of the rural areas are covered by certified state inspection stations. Statewide safety inspections remain to be carried out in certified state inspection stations, as well.

The $0.12 per vehicle figure assumes that the geographic coverage for I/M is obvious to the public (i.e., county lines). Alternative 6 splits program coverage along certain "urbanized area boundaries" that are not readily discernible to most individuals. In fact, these boundary lines are liable to appear quite arbitrary to the public. They will require a more extensive information effort than a uniform I/M program would.

---

*GCA, Viable Alternative Types of Inspection Maintenance Programs for St. Louis, Final Report, Contract No. 68-02-1376, Task Order No. 28. For U.S. EPA, June, 1977.

TABLE 132. ESTIMATED 1987 VEHICLE REGISTRATIONS FOR INDIANA AREAS POTENTIALLY AFFECTED BY I/M

County	1982 Registrations*
Allen	208,149
Clark	60,876
Floyd	40,995
Lake	337,649
Marion	517,243
Porter	77,988
St. Joseph	159,415
7 County total	1,402,315
Statewide total	3,794,847

---

*Estimates are based on 1977 registration figures obtained from the Indiana Bureau of Motor Vehicles. Motor vehicle registration projections are calculated using a 3 percent annual growth rate.

Also, in the urbanized portions of the seven counties, vehicle owners will have to travel to two separate facilities for emissions and safety inspections to be accomplished. Since no program to date has required this "two stop" inspection there are no figures on which to base a cost estimate. The costs for alternative 6 will be higher as a result of the complexities that its public information program must convey.

Alternatives 2, 3, and 4 all propose seven-county program coverage. The type of inspection facility is uniform over the seven counties removing the complexity present in alternative 6. Assuming a 1982 vehicle population for this area of 1,402,315, public relations costs will run around $168,000.

Alternative 5 proposes seven-county coverage also, but it splits emissions testing along "urban-rural" boundaries. In the urbanized sections of these seven counties motorists will be required to go through a "two-stop" inspection, contractor for emissions inspection and certified state inspection station for safety. Alternative 5 also extends program coverage to portions of Elkhart, Hamilton and Johnson Counties but leaves sections of them outside I/M.

The extreme complexity of this alternative will be difficult to present to the public. In addition to defining the urban-rural division of the seven-county area, a public relations program must adequately explain why some, but not all, members of Elkhart, Hamilton and Johnson Counties will be subjected to I/M requirements.

No program of this complexity has ever been considered by any other state. The problems that it might raise will probably at the least double public relations costs. The vehicle population of the three partially affected counties that will be covered by a CSIS I/M network is 234,544. Assuming a $0.25 per vehicle cost, public information costs may be around $58,600 in this area alone. This cost must in turn be added to that of the contractor program in the five urbanized areas, assumed in Section 7 to be $274,664 for initial costs (annual costs are assumed to be the same). It should be noted that the total public relations cost for this alternative may be even higher than that resulting from the sum of the above costs, depending on the difficulty of public education and the acceptance of this program.

APPENDIX D

SENSITIVITY OF BREAK-EVEN FEES

Break-even fees are dominated by the annual operating costs in all of the centralized (contractor) approaches. The annual operating cost is highly dependent on test personnel wages and overhead. By increasing test personnel wages 25 percent to reflect unionization or raises over a time span of 3 years, the resultant increase in f_c (fee in constant 1978 dollars) would range from 9.1 to 14.3 percent. Current and increased f_c are presented in Tables 133 and 134 for interest values, (i), of 0.03 and 0.06, respectively.

TABLE 133. INCREASE IN BREAK-EVEN FEES (f_c) WITH A 25% INCREASE IN TEST PERSONNEL WAGES (i = 0.03) (CONSTANT 1978 DOLLARS)

Alternative	Current f_c ($)	f_c with 25% ($) wage increase	Increase (%)
3 (paid retest)	3.013	3.311	9.9
3 (free retest)	3.917	4.305	9.9
4 (paid retest)	9.366	10.705	14.3
4 (free retest)	12.176	13.917	14.3
5 (paid retest)	3.219	3.528	9.6
5 (free retest)	4.185	4.587	9.6
6 (paid retest)	3.219	3.528	9.6
6 (free retest)	4.185	4.587	9.6

TABLE 134. INCREASE IN BREAK-EVEN FEES (f_c) WITH A 25% INCREASE IN TEST PERSONNEL WAGES ($i = 0.06$) (CONSTANT 1978 DOLLARS)

Alternative	Current f_c ($)	f_c with 25% ($) wage increase	Increase (%)
3 (paid retest)	3.172	3.471	9.4
3 (free retest)	4.124	4.512	9.4
4 (paid retest)	9.735	11.074	13.8
4 (free retest)	12.656	14.396	13.7
5 (paid retest)	3.390	3.699	9.1
5 (free retest)	4.407	4.809	9.1
6 (paid retest)	3.390	3.699	9.1
6 (free retest)	4.407	4.809	9.1

APPENDIX E

DETAILED DESCRIPTION OF COSTS AND FEE CALCULATIONS

This appendix contains a detailed description of the methodology used in calculating annual costs and fees. First, capital and start-up cost are converted to annual figures in real dollars. These figures are then added to annual operating and administrative costs, so as to arrive at the yearly cost of the whole project. A uniform real dollar fee is then calculated, along with a second fee that is uniform in actual dollars.

INITIAL CAPITAL COSTS

The capital investment in equipment is assumed to yield equal benefits for each of 5 years and be fully depreciated thereafter. The interest rate is the marginal return on capital in the absence of inflation.

In annualizing equipment costs, the following formulas are employed. The net present value of an investment (NPV) that yields 1 dollar of service for each of n years at a capital growth rate of i is:

$$\mathrm{NPV} = \sum_{k=1}^{n} \frac{1}{(1+i)^k} = 1 - \left[(1+i)^{-n}\right] \Big/ i \tag{1}$$

Thus, an investment of 1 dollar yields annual benefits: $\frac{1}{\mathrm{NPV}} = \frac{i}{1-(1+i)^{-n}}$ for each of n years. Thus $\frac{1}{\mathrm{NPV}}$ represents amortized costs in constant dollars. In the case of $n = 5$ and $i = 0.03$, $\mathrm{NPV} = 4.580$ and $\frac{1}{\mathrm{NPV}} = 0.2184$, and in the case of $n = 5$ and $i = 0.06$, $\mathrm{NPV} = 4.212$ and $\frac{1}{\mathrm{NPV}} = 0.2374$.

For buildings and structures, investment is assumed to yield a constant flow of capital services for 20 years and be fully depreciated thereafter. The above formulas are employed with $n = 20$. This yields $\mathrm{NPV} = 14.877$ and $\frac{1}{\mathrm{NPV}} = 0.067$ when $i = 0.03$; and $\mathrm{NPV} = 11.469$ and $\frac{1}{\mathrm{NPV}} = 0.087$ when $i = 0.06$. If structures are liquidated before 20 years, their sale price is assumed to be the capitalized flow of the remaining capital services (i.e., if sold after j years, the sale price will be:

$$\sum_{k=1}^{20-j} \left(\frac{1}{NPV(1+i)}\right)^k$$

for each dollar of initial investment). This assumption enables use of the above amortization factor, $\frac{1}{NPV}$, without making further adjustments.

Land is assumed to yield a constant level of services in perpetuity ($n = \infty$ in the above formulas). So a dollar investment yields $\frac{1}{NPV} = i$ dollars of service each year. Again, we assume the resale price of investment (in this case, land) is the capitalized flow of the remaining services. This implies that the value of land is unchanged from year to year, and the annual cost of capital service is (land value)*(i) regardless of when land liquidation occurs.

One-Time Start-Up Costs

One-time start-up costs, like capital costs, occur at the beginning of the project. However, these expenditures do not yield a flow of services or have a resale value, as do capital investments. Even still, start-up expenditures can be recouped over a period of time. We assume a 5-year period of repayment with equal yearly payments in constant dollars. Therefore, the annual cost of each dollar of start-up cost is: $\frac{1}{NPV} = \frac{i}{1-(1+i)^{-5}}$, which equals 0.2184 when $i = 0.03$ and 0.2374 when $i = 0.06$.

Annual Operating and Administrative Costs

These costs are presented as annual figures. To obtain total annual cost in constant dollars, the annual operating and administrative costs are added directly to the annual capital and start-up costs.

Fee Calculations

A fee, f_c, reflecting constant dollars, is calculated by dividing total annual costs by the number of paid inspections per year. This fee is designed to recoup all of the costs included in Table 2.

Interest Rates and Constant Dollars

All of the proceeding calculations are performed in constant 1978 dollars. To get figures in actual dollars for years other than 1978, all annual costs, amortized costs, and fees must be increased by the amount of inflation since 1978.

Interest rates used with constant dollars are those reflecting the real return on capital. Actual interest rates include compensation to offset the diminished buying power of money under inflation, and thus, are inappropriate here. In this study, we employ two real rates of return for capital, 3 percent and 6 percent. These rates are lower and upper bounds; the exact rate depends upon the source of financing (i.e., debt, equity, or taxpayers' foregone investment).

Inflation

The above-mentioned fee is in real (constant) dollars and must be adjusted for inflation. These adjustments will cover increased operating costs as well as the difference between the market rate of interest and the real rate of return on capital.

A second fee, f_a, will also be calculated. This fee will be uniform in actual dollars over time. In calculating this fee, an inflation rate ρ must be assumed.* In this report, it will be assumed that $\rho = 0.07$. For notational convenience, let r = market rate of interest and i = real return on capital ($r = i+\rho$). Then, for investments (capital costs and start-up costs) an assumption of uniform capital services in actual dollars allows the use of the previous formulae for $\frac{1}{NPV}$ with r substituted for i.† The factors for amortization are shown in Table E-1 below:

TABLE 135. FEE, f_a, AMORTIZATION FACTORS

Cost category	$\frac{1}{NPV}$	i=0.03	i=0.06
Land	r	0.10	0.13
Buildings and structures	$\frac{r}{1-(1+r)^{-20}}$	0.117	0.143
Equipment and start-up costs	$\frac{r}{1-(1+r)^{-5}}$	0.264	0.284

Annual operating and administrative costs must be transformed from constant to actual dollars. Actual annual cost, is equal to the product of (1) annual real cost and (2) a transformation factor, T. This transformation factor is determined from:

---

*It shall be noted that the first fee, f_c, was independent of ρ.

†Capital investments no longer yield uniform services, but now yield accelerated depreciation.

$$T = \frac{1}{\sum_{k=1}^{n} \left(\frac{1}{1+r}\right)^k} \sum_{k=1}^{n} \left(\frac{1+\rho}{1+r}\right)^k = \frac{r}{1-(1+r)^{-n}} \sum_{k=1}^{n} \left(\frac{1}{1+ \frac{1+r}{1+\rho} -1}\right)^k$$

$$= \frac{r(1+\rho)}{i} \left(\frac{1-(1+i/1+\rho)^{-n}}{1-(1+r)^{-n}}\right)$$

where n = number of years = 5. Therefore, when i = 0.03 then T = 1.215, and when i = 0.06 then T = 1.210.

The fee, f_a, is calculated in a manner similar to the original fee, f_c. To arrive at f_a, annualized costs are summed and divided by the annual number of paid inspections.

APPENDIX F

UNIFORM FEE IN ACTUAL DOLLARS

The fees previously presented in this report must increase with inflation, even after the I/M program begins. Table 136 reports fees that remain constant over the first 5 years of the I/M program. These fees are still reported in 1978 dollars and must increase with inflation until the beginning date of the program. However, once the I/M program commences, the fee remains the same for the next 5 years (assuming an annual inflation rate of 7 percent over the 5-year period). A complete description of the assumptions and methodologies used with these fees appears in Appendix E.

The uniform fee in actual dollars is reported for contractor and state operations only. F_a averages the cost of performing inspections over 5 years. Since the cost of an inspection rises over time in dollar terms, the average fee will exceed the dollar cost of an inspection in early years and fall short of actual costs in later years.

This has important implications regarding the length of time over which a contractor or CSIS must perform inspections. If a CSIS is not required to perform inspections for the entire 5-year period, it will perform inspections during the early years of program operation when the fee collected (f_a) is greater than CSIS inspection costs. Stations will not perform inspections during later years when f_a falls short of inspection costs. Thus, a uniform fee over time is an impractical concept when applied to firms that are not contractually bound to provide service for the entire 5-year period. That is, f_a is unfeasible when dealing with CSIS network participants who are not so obligated. Since the contractor and state are legally bound to provide services over time, f_a is extremely useful in these cases.

TABLE 136. FEE f_a AND COST COMPONENTS (1978 DOLLARS)

Cost components for f_a[*]	Alternative 1 emissions sticker fee (statewide)	Alternative 2 emissions sticker fee (seven counties)	Alternative 3 contractor's fee (seven counties)	Alternative 4 contractor's fee (seven counties)	Alternative 5 and 6 contractor's fee (five urbanized areas)	Alternative 5 emissions sticker fee (nonurbanized part of seven counties)	Alternative 6 emissions sticker fee (part of state not in urbanized areas)
with i = 0.03[†]							
I. Annualized capital costs							
1. Land	-	-	338,000	722,000	331,000	-	-
2. Buildings	-	-	1,007,000	2,149,000	985,000	-	-
3. Equipment	237,000	86,000	838,000	2,947,000	824,000	18,000	165,000
II. Annualized startup costs	864,000	317,000	860,000	1,405,000	881,000	68,000	600,000
III. Annual operating costs	3,647,000	1,318,000	5,339,000	20,392,000	5,201,000	279,000	2,535,000
IV. Annual administrative costs	130,000	130,000	1,151,000	1,152,000	1,233,000	-	-
Total annual cost	4,878,000	1,851,000	9,533,000	28,767,000	9,455,000	365,000	3,300,000
Fee f_a with paid emissions retest	0.80	0.76	3.92	11.828	4.131	1.250	0.870
Fee f_a with free emissions retest	1.04	0.99	5.10	15.377	5.370	1.625	1.130
with i = 0.06[†]							
I. Annualized capital costs							
1. Land	-	-	440,000	938,000	430,000	-	-
2. Buildings	-	-	1,231,000	2,608,000	1,196,000	-	-
3. Equipment	255,000	92,000	902,500	3,170,000	886,000	20,000	177,000
II. Annualized startup costs	930,000	341,000	925,000	1,512,000	947,000	73,000	646,000
III. Annual operating costs	3,632,000	1,312,000	5,317,000	20,308,000	5,180,000	278,000	2,525,000
IV. Annual administrative costs	130,000	130,000	1,146,000	1,147,000	1,228,000	-	-
Total annual cost	4,947,000	1,875,000	9,961,000	29,683,000	9,867,000	371,000	3,348,000
Fee f_a with paid emissions retest	0.81	0.77	4.10	12.205	4.311	1.267	0.882
Fee f_a with free emissions retest	1.05	1.00	5.33	15.866	5.604	1.648	1.146

[*] These figures are not to be construed as annual costs.

[†] i = interest rate in absence of inflation.

Note: f_a = uniform fee in actual dollars.

APPENDIX G

DETAILED DESCRIPTION OF METHODOLOGY FOR CALCULATION OF MOTOR VEHICLE INSPECTIONS REQUIRED IN 1982 AND 1987

PROJECTION METHODOLOGY

Projecting any statistic into the future is accomplished using the following formula:

$$(P_{T_1})\,(A)^{(T_2 - T_1)} = P_{T_2}$$

where: P_{T_1} = the value of the statistic at time T_1, also called the "base year statistic"

A = the annual rate of growth of statistic P

$T_2 - T_1$ = the length of time involved in the projection

P_{T_2} = the value of the statistic at time T_2, also called "the projection."

In order to project motor vehicle population statistics, therefore, it is necessary to have an accurate base year statistic and an accurate annual rate of growth. Neither of these variables was available on an urbanized or rural area basis; however, the regional planning agencies in each of the five nonattainment areas did provide accurate 1975 estimates for urban and rural populations within their jurisdictions. By projecting these populations into the future and multiplying the resulting figures by the ratio of motor vehicles per capita, motor vehicle population projections can be derived. These 1975 population statistics are therefore used as base year statistics; they are shown in Table 137.

The regional planning commissions did not supply annual growth rates for the populations in their jurisdictions; these can be estimated, however, by using U.S. Bureau of the Census county data. It is assumed that the populations of both the urbanized and rural portions of the counties in question will grow at the same rates as they did from 1960 to 1975. Given the 1960 and the 1975 populations, the annual rate of growth can be calculated using the following formula:

$$e^{\frac{1}{15}\ln\left(\frac{P\ 1975}{P\ 1960}\right)} = A$$

TABLE 137. 1975 (BASE YEAR) POPULATIONS, URBAN AND RURAL PORTIONS OF NONATTAINMENT COUNTIES

Area	1975 Population	
	Urban	Rural
Indianapolis		
Marion County	782,139	0
Johnson County	28,206	38,674
Hamilton County	20,577	47,683
Louisville		
Clark County	48,201	37,299
Floyd County	40,978	19,132
South Bend		
St. Joseph County	207,799	37,946
Elkhart County	62,143	73,562
Fort Wayne		
Allen County	246,640	54,981
Gary-Hammond		
Lake County	509,471	37,286
Porter County	46,248	50,079

Source: Indiana Regional Planning Agencies' estimates, 1978.

TABLE 138. ANNUAL RATES OF POPULATION GROWTH, 1960-1975

Area	Annual rate of growth (percent)
Indianapolis	
Marion County	0.77879
Johnson County	2.87748
Hamilton County	3.60530
Louisville	
Clark County	1.87871
Floyd County	0.66517
South Bend	
St. Joseph County	0.05710
Elkhart County	1.41005
Fort Wayne	
Allen County	1.45679
Gary-Hammond	
Lake County	0.42061
Porter County	3.17353

Source: GCA calculations, 1978.

TABLE 139. POPULATION PROJECTIONS, 1982 AND 1987

Area	Population			
	1982		1987	
	Urban	Rural	Urban	Rural
Indianapolis				
Marion County	825,787	0	858,447	0
Johnson County	34,402	47,170	39,645	54,358
Hamilton County	26,367	61,099	31,475	72,937
Louisville				
Clark County	54,909	42,489	60,264	46,634
Floyd County	42,925	20,041	44,371	20,716
South Bend				
St. Joseph County	208,631	38,098	209,227	38,207
Elkhart County	68,542	81,137	73,513	87,021
Fort Wayne				
Allen County	273,087	60,877	293,697	65,471
Gary-Hammond				
Lake County	524,662	38,398	535,789	39,212
Porter County	57,553	62,321	67,284	72,858

Source: GCA calculations, 1978.

Table 138 shows the annual rates of growth from 1960 to 1975 for the 10 counties in question.

Substituting these annual growth rate figures and the above base year population figures into the projection formula above, population estimates for 1982 and 1987 can be derived for the urban and rural portions of the 10 counties. These population projections are shown in Table 139.

The ratio of motor vehicles per capita can be calculated using U.S. Bureau of the Census statistics; using a procedure similar to that used above for population statistics, an annual rate of growth for this ratio can also be calculated. Therefore, using the annual rate of growth and the 1975 ratio as a base year statistic, the 1982 and 1987 ratios of motor vehicles per capita can be projected, as shown in Table 140.

TABLE 140. CALCULATION OF MOTOR VEHICLES/CAPITA RATIO FOR 1982 AND 1987

Year	Statewide population	Motor vehicle statewide population	Motor vehicles per capita
1960	4,674,000	2,046,000	0.4377
1975	5,313,000	3,315,000	0.6239
1982	5,640,000	4,152,000	0.7362
1987	5,887,000	4,877,000	0.8285

Source: Bureau of the Census data and GCA calculations, 1978.

Multiplying the ratios in the last column of the above table by the population figures tabulated above yields an estimate of the total motor vehicle population for each area in question. These figures are shown below in Table 141.

Two additional factors must be considered in calculating the total number of inspections required for a given program alternative. First, a certain percentage of motor vehicles will be exempted from the program due to the fact that they are over 13 years old. This percentage is assumed not to exceed 4 percent of the total motor vehicle population for a given area. Second, a certain percentage of the motor vehicles tested will fail the inspection and require reinspection before registration will be allowed. If the stringency of the test is 30 percent, then the total number of inspections required for a given area will be:

$$(\text{inspections}) = (\text{motor vehicles})\ (0.96)\ (1.3)$$

Table 142 shows the total inspections reuiqred for the 10 counties and for the entire state. These figures were used in deriving network requirements and inspection fees for all the alternatives.

TABLE 141. MOTOR VEHICLE POPULATIONS, 1982 AND 1987

Area	Motor vehicle population			
	1982		1987	
	Urban	Rural	Urban	Rural
Indianapolis				
Marion County	609,917	0	711,211	0
Johnson County	25,326	34,725	32,845	45,035
Hamilton County	19,411	44,979	26,077	59,980
Louisville				
Clark County	40,422	31,279	49,928	38,636
Floyd County	31,600	14,754	36,761	17,163
South Bend				
St. Joseph County	153,587	28,046	173,442	31,654
Elkhart County	50,458	59,730	60,904	72,096
Fort Wayne				
Allen County	201,038	44,816	243,324	54,242
Gary-Hammond				
Lake County	386,239	28,267	443,894	32,487
Porter County	42,369	45,879	55,744	60,362

Source: GCA calculations, 1978.

TABLE 142. MOTOR VEHICLE INSPECTIONS REQUIRED, 1982 AND 1987

Area	Inspections required			
	1982		1987	
	Urban	Rural	Urban	Rural
Indianapolis				
Marion County	758,680	0	887,592	0
Johnson County	31,607	43,337	40,990	56,204
Hamilton County	24,226	56,134	32,544	74,855
Louisville				
Clark County	50,447	39,036	62,310	48,218
Floyd County	39,437	18,411	45,878	21,419
South Bend				
St. Joseph County	191,677	35,001	216,455	39,504
Elkhart County	62,972	74,543	76,008	89,976
Fort Wayne				
Allen County	250,895	55,930	303,544	67,694
Gary-Hammond				
Lake County	482,026	35,277	553,979	40,544
Porter County	52,876	57,257	69,568	75,332
Statewide	5,181,696		6,086,496	

Source: GCA calculations, 1978.

GLOSSARY

accuracy: The degree by which an instrument is able to determine the true concentration of a pollutant in the exhaust gas sampled.

actual dollars: The face value of money in any particular year. With inflation, the buying power of actual dollars decreases.

air contaminants: Any fumes, smoke, particulate matter, vapor gas, or combination thereof but excluding water vapor or stream condensate.

air-to-fuel ratio: The expression of the proportional mixture of air and gasoline created by the carburetor. Usually expressed as a numerical relationship such as 14:1, 13:1, etc.

ambient air: The surrounding or outside air.

amortization factor: The annual cost of 1 dollar of capital expenditure. Amortization factors are applied to capital costs to determine annual costs.

calibration gases: A blend of HC and CO gases using nitrogen as a carrier gas.

carbon monoxide: A nonirritating, colorless, odorless gas at standard conditions which has the molecular form of CO.

catalytic converter system: A device to reduce automobile exhaust emissions by converting CO and HC emissions to harmless carbon dioxide and water.

CBD: Central Business District.

centralized facility: A contractor owned and operated inspection site containing more than one inspection lane and located within easy access to as much of the surrounding motor vehicle population as possible. This facility is best suited for high density population areas.

certified mechanic: An individual licensed in Indiana to inspect vehicles and to install, repair, and adjust motor vehicle engine components and pollution control devices in order that the motor vehicle meet applicaable safety and emissions standards.

certified state inspection station (CSIS): A privately-owned establishment licensed in Indiana for the inspection of motor vehicles, including the installation, repair and adjustment of motor vehicle engine components and pollution control devices in order that the motor vehicle meet applicable safety and emissions standards.

chassis dynamometer: A machine equipped with two parallel rollers which support the rear wheels of a motor vehicle. When positioned on the dynamometer the vehicle may be "driven" to simulate the loadings the engine would experience when the vehicle is operated on the road. A power absorption unit is connected to the rollers to simulate the loading from the various sources of fluid and mechanical friction present during road operation. Weights can also be coupled to the rollers to simulate the inertial effects of vehicle mass during acceleration and decelleration.

constant dollars: See real dollars.

crankcase emissions: The products of combustion emitted into the ambient air from portions of the engine crankcase ventilation or lubrication system.

decentralized facility: A privately-owned and operated inspection station containing generally no more than one testing/repair bay and located within a network covering a large geographic area so as to provide as much access possible to a more scattered motor vehicle population. This facility siting approach is best suited to less densely settled areas.

degradation: The decreased effect of I/M on emission reduction due to normal wear of engine system.

deterioration: A synonym for degradation indicating an increase in emission levels due to wear.

drift: The amount of meter reading change over a period of time. Zero drift refers to change of zero reading. Span drift refers to a change in reading of a calibration point on the upper half of the scale. The calibration point is established by reading a calibration gas of known concentration.

emission inspection program: An inspection and maintenance program (I/M) in which each motor vehicle is subjected at specified intervals to a test of its emissions under specified conditions. Exhaust emissions levels are compared with a standard established for the vehicle class. If the emissions are higher than the standard, the vehicle is failed and must be adjusted or repaired to bring its emissions back into compliance with the standards.

exhaust gas analyzer: An instrument for measuring the relative amount of various component gases in the exhaust emissions of a motor vehicle.

exhaust emissions: The products of combustion emitted into the ambient air from any opening downstream of the exhaust ports of a motor vehicle engine.

hang-up: A condition occurring when HC clings to the surface of the sampling and analyzer system that is in contact with the gas sample stream causing an erroneous indication of HC in the measured value.

heavy-duty vehicle: Any motor vehicle designed for highway use which has a gross vehicle weight of more than 8,500 pounds.

hydrocarbons (HC): An organic compound containing only atoms of hydrogen and carbon.

idle test: An emissions inspection program that measures the exhaust emissions from a motor vehicle operating at constant idle speed with the transmission in neutral gear.

independent contractor: Any person, business firm, partnership or corporation with whom the state may enter into an agreement providing for the construction, equipment, maintenance, personnel, management and operation of official inspection stations.

inspection and maintenance program (I/M): A program designed to reduce emissions from in-use motor vehicles by identifying vehicles that need emissions related maintenance and requiring that maintenance be performed.

inspection facility: A centralized establishment designed for inspection of motor vehicles, their exhaust emissions, and pollution control devices for compliance with applicable standards.

inspector: An individual who inspects motor vehicles, their exhaust emissions, and pollution control devices for compliance with applicable standards.

in-use vehicles: Generally, those motor vehicles registered with the Indiana Bureau of Motor Vehicles for use on public rights of way.

key mode test: A loaded mode test in which exhaust emissions are measured at constant high and low cruise speeds and at idle. The cruise speeds and dynamometer power absorption settings vary with the weight class of the vehicle. The dynamometer loading in the high cruise range is higher than normal load in order to more efficiently expose malfunctions leading to high emissions.

kWh (kilowatt hour): The unit of work or energy equal to that expended by 1000 watts in 1 hour.

light-duty truck (LDT) 1 and 2: LDT 1 refers to the category of trucks weighing less than 6500 pounds; LDT 2 is the category of trucks weighing from 6500 to 8500 pounds.

light-duty vehicle (LDV): A motor vehicle designed for highway use of less than 8501 pounds gross vehicle weight. Further distinctions are usually made between light-duty automobiles and light-duty trucks such as pickup trucks.

loaded mode test: An emission inspection program that measures the exhaust emissions from a motor vehicle operating under simulated road load on a chassis dynamometer.

manufacturer's specifications: The specifications or settings established by the manufacturer for proper motor vehicle operation. These settings must be followed in order to maintain proper emission controls and vehicle performance.

market rate of interest: An interest rate that includes the real return on capital, a risk premium, and compensation for inflation.

metropolitan planning organization (MPO): A federally legislated planning authority given major responsibility for projects involving federal funding. Its boundaries usually include the metropolitan area in which it is located as well as the surrounding urbanized areas, as determined by the governor(s) of the state(s) involved.

model year of vehicle: The production period of new vehicle or new vehicle engines designated by the calendar year in which such period ends.

motorcycle (MC): A two wheeled automotive vehicle having one or two saddles and sometimes a third wheel for support of a side car.

motor vehicle: Any automotive vehicle not operated on rails but one with rubber tires which is designed primarily for use on public rights-of-way and which is used to transport persons and property.

National Highway Traffic Safety Administration (NHTSA): An arm of the U.S. Department of Transportation (DOT) with primary responsibility for the administration of such standards as Periodic Motor Vehicle Inspection, Vehicle In Use Inspection Standards, Motor Vehicle Registration and Motorcycle Safety. Along with another arm of the U.S. DOT, the Federal Highway Administration (FHA), NHTSA has issued guidelines in the form of a "Highway Safety Program Manual" to assist state and local agencies in implementing their highway safety programs.

net present value (NPV): The present value of future benefits and cost. When actual dollars are used, benefit and costs are discounted by the market rate of interest. When real dollars are used, benefits and costs are discounted by the real return on capital.

nonattainment area: An area (generally a county or cluster of counties) where it has been determined that the National Ambient Air Quality Standards for one or more pollutants will not be attained by 31 December 1982.

photochemical oxidants (O_x): Those pollutants resulting from the chemical combination of reactive hydrocarbons with nitrogen oxides in the presence of sunlight. These include ozone and other complex chemical compounds, which are dangerous to human health.

positive crankcase ventilation (PCV): A system designed to return blowby gases from the crankcase of the engine to the intake manifold so that the gases are burned in the engine. Blowby gas is unburned fuel/air mixture which leaks past the piston rings into the crankcase during the compression and ignition cycles of the engine. Without positive crankcase ventilation these gases, which are rich in hydrocarbons, escape to the atmosphere.

prescribed inspection procedure: Approved procedure for identifying vehicles that need emissions control related maintenance.

queue: The line of vehicles waiting to enter contractor-operated inspection facility lanes. There must be waiting area space to accommodate these vehicles.

real dollars: (Sometimes called constant dollars.) Dollars that have the same buying power from year to year. To arrive at actual dollars, real dollars must be increased by the amount of inflation. For example: with an annual inflation of 7 percent, $100 in year x is equal to $107 actual dollars in year x + 1.

(real) rate of return on capital: The return on capital in the absence of inflation. This is equal to the marginal product of capital when combined with land and labor in production.

registered owner: An individual, firm, corporation or association whose name appears in the files of the motor vehicle registration division of the department of motor vehicles as the person to whom the vehicle is registered.

repeatability: The instrument's capability to provide the same value for successive measures of the same sample.

residence time: The total amount of time it takes a vehicle to pass through an I/M facility.

response time: The period of time required by an instrument to provide meaningful results after a step change in gas concentration level initiated at the tailpipe sample probe.

smoke: Small gasborne and airborne particles, exclusive of water vapor, arising from a process of combustion in sufficient number to be observable.

Statement of Inspection and Receipt or Inspection Receipt: A form which is issued upon completion of inspection which records the results of the inspection and serves as proof of said inspection for vehicle owner.

stringency factor: The percentage of total vehicles tested in an inspection/maintenance program in a given time period that fail inspection and are required to have maintenance performed.

tampering: The illegal alteration, modification, or disconnection of emission control devices or adjustments or manufacturer tuning specifications on motor vehicles for the purpose of controlling vehicle emissions.

throughput time: The length of time a vehicle spends at the slowest position in a lane within the I/M facility. This is used to compute capacity or the number of vehicles which may pass through the I/M facility in one day's time.

United States Environmental Protection Agency (U.S. EPA): Established in the executive branch of the federal government as an independent agency in December, 1970, and created to permit coordinated and effective governmental action on behalf of the environment.

vehicle dealer: An individual, firm, corporation or association who is licensed to sell motor vehicles.

vehicle emissions standard: A specific emission limit allowed for a class of vehicles. The standard is normally expressed in terms of maximum allowable concentrations of pollutants (e.g., parts per million). However, a standard could also be expressed in terms of mass emissions per unit of time or distance traveled (e.g., grams per mile).